Bulletin 317 March 1935

UNIVERSITY OF MINNESOTA
AGRICULTURAL EXPERIMENT STATION
AND
MINNESOTA
DEPARTMENT OF CONSERVATION

LAND ECONOMIC SURVEY
of Hubbard County, Minnesota

UNIVERSITY FARM, ST. PAUL

MINNESOTA LAND ECONOMIC SURVEY

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* During the period 1929-30, the administration of the survey was under the Hon. R. P. Chase, State Auditor; Mr. G. M. McCullough, Commissioner of Game and Fish, and Mr. G. M. Conzet, Commissioner of Forestry and Fire Prevention.

PREFACE

It has long been apparent to all those who have given the question serious consideration that the settlement and development of the United States has been largely haphazard and undirected. Federal and state land policies, in the main, have encouraged the rapid transfer of public lands to private ownership with little regard for the uses to which the land was best adapted or to the demand for its products.

As we look back over the last 150 years of the history and development of the country, it is not difficult to observe very definite shortcomings in both the federal and state land policies. Large areas of land were thrown open to settlement long before there was any need for their being opened to settlement; valuable resources, especially timber resources, were exploited and destroyed; agricultural development occurred where it is now apparent that agriculture should not have been encouraged; valuable water-power resources that should have remained in public ownership passed into private ownership; the so-called scattered settler was encouraged, and expensive local governmental agencies were developed during the "boom period" which now cannot be adequately maintained and supported by the existing tax base. A thousand and one land-use problems we now face are the direct and indirect results of our past land policies or lack of policies.

Little is to be gained, however, by regretfully looking back to what might have been done in the disposition of the public domain. A realistic approach to the land-use problem demands that we face it as it exists today and that we mold and guide future development in such a way as to mitigate as far as possible the harsh effects of past mistakes and contribute as far as possible to the benefit and to the social and economic security of the greatest number of people. Such a program calls for land-use planning, and land-use planning in turn calls for the full and adequate study of two sets of factors.

The first of these factors involves a knowledge of the resources of the land—the character of the soil, topography, geological resources, and other factors. The second deals with an economic inventory of the area—the history of occupation and exploitation, present population and its distribution, land ownership, assessed valuation, taxation, tax delinquency, local improvements, and cost of local government.

To obtain the necessary information for a planned development of the state, the Minnesota State Legislature authorized and directed the Department of Conservation, in co-operation with the Department of

Agriculture of the University of Minnesota to make a land economic survey of all lands in the State of Minnesota.

Soon after the passage of the act, a conference was held of representatives of the Department of Conservation and the Department of Agriculture of the University. As a result of the conference, the general responsibility for the land economic survey was delegated jointly to the chairman of the Conservation Commission and the chairman of the Land Economic Survey Committee of the Department of Agriculture of the University of Minnesota. It was agreed further that the technical responsibility for the various activities of the survey be delegated as follows:

The chief of the division of soils, Department of Agriculture, University of Minnesota, was held responsible for the organization and selection of the field force and the proper execution and final preparation of all maps and manuscripts dealing with the soil inventory of the survey.

The chief of the division of agricultural economics, Department of Agriculture, University of Minnesota, was held responsible for the organization and selection of the field force and the proper execution and final preparation of all maps and manuscripts dealing with the economic aspects of the survey.

The director of forestry, Department of Conservation, and the chief of the division of forestry, University of Minnesota, were held jointly responsible for the organization and selection of the field force and the proper execution and final preparation of all maps and manuscripts dealing with the forest inventory of the area.

Mr. Raymond Stevens, of the division of forestry, Department of Conservation, was placed in charge of the survey field party. The success of the field work of the survey is largely due to his zeal and efforts. The committee also gratefully acknowledges the co-operation of the Lake States Forest Experiment Station in connection with the collection of the data for, and the preparation of, the report of the forest inventory. To Mr. Russell Cunningham, of the Lake States Forest Experiment Station staff, the committee is particularly indebted. The soil survey was made in co-operation with the Bureau of Chemistry and Soils, U. S. Department of Agriculture, represented by Curtis Marbut, Chief of the Division of Soil Survey, Mark Baldwin, Inspector, and three soil mappers. Valuable assistance was also obtained from many of the Hubbard County officials who gave freely of their time and who on all occasions furnished such factual material as was available. To all of these and to many others who contributed directly or indirectly to the work of the survey, the committee expresses its appreciation.

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I. INTRODUCTION

AUTHORIZATION FOR THE SURVEY

Chapter 247 of the session laws of 1929 of the State of Minnesota reads as follows:

Chapter 247.—S.F. No. 47

"An act authorizing and directing the Department of Conservation to make a land economic survey of all lands in the State of Minnesota and appropriating money therefor.

"Be it enacted by the Legislature of the State of Minnesota:

"Section 1. Department of Conservation to make land survey.—The department of conservation is authorized and directed to make, in co-operation with the department of agriculture of the University of Minnesota, a land economic survey of all lands in the State of Minnesota. Said survey shall first be made of lands in the so-called forest area of northern and northeastern Minnesota.

"Sec. 2. Department to recommend disposition.—As said land economic survey of each county is completed the department of conservation shall recommend to the legislature the proper use and disposition of state lands located within such county.

"Sec. 3. Appropriation.—The following sums of money, or so much thereof as may be necessary, are hereby appropriated from any money now in the state treasury, not otherwise appropriated, to be expended by the department of conservation for a land economic survey as herein required.

"Available for the year ending June 30, 1930..... $20,000
Available for the year ending June 30, 1931..... 20,000
Approved April 19, 1929."

The land economic survey, of which this is the report, was undertaken in response to the direction of the legislature embodied in the act quoted above. The legislature at its 1931 session did not make an appropriation for continuing the survey but appropriated $6,000 for completion and publication of the work previously undertaken.

It will be noted that the legislature did not prescribe whether the survey should be an extensive one, gathering limited material for a large area, or an intensive one, getting detailed information for a limited area. Detailed surveys had been undertaken previously in both Michigan and Wisconsin. The Interim Reforestation Commission created by the legislature at its 1927 session had made a study of the Michigan Land Economic Survey and had recommended that such a survey be made in Minnesota, and it was assumed that this was the type of survey which was intended. Section 2 of Chapter 247 also is suggestive of this intent on the part of the legislature. In view of these considerations, plans were developed for an intensive survey.

The object of a land economic survey is to assemble information on the various factors involved in the utilization of the natural resources of the area studied that will serve as a guide in determining upon the

best program of utilization of these resources. Generally speaking, such a survey includes a study of the soil, the forest cover, forest growth, agricultural and industrial development, taxation, public expenditures, human resources, wild life, recreational possibilities, and the factors influencing the development of existing resources.

While soil surveys had been made in various counties, a land economic survey covering forest and economic factors in addition to the soil had not been undertaken previously in Minnesota, and work of this kind was under way in only a few other states. Michigan was the first state to develop such a survey. The Michigan Land Economic Survey was authorized in 1917, but, because of the World War, an appropriation was not made to start the work until 1922. Michigan has conducted the survey continuously since the latter date. Wisconsin is carrying on similar work, started in 1928.

The experiences of Michigan and Wisconsin in work of this kind were drawn upon as guides in the development and carrying out of the survey in Minnesota.

REASONS FOR SELECTING HUBBARD COUNTY FOR STUDY

The legislative act authorizing the Minnesota Land Economic Survey specifically states that the survey shall first be made of lands in the so-called forest area of northern and northeastern Minnesota. The choice in the selection of the particular county was therefore limited.

It was also necessary to give consideration to the total area of the counties of the cut-over region. It was apparent at the beginning that the legislative appropriation made in 1929 to carry on the work for the biennium was insufficient to complete an intensive land economic survey of any one of the larger counties.

In the final selection of the specific county to be studied, adequate consideration was given to the question of how representative each of the counties in the cut-over region was of a larger, general region. That is, it was hoped that a county could be selected, the general conditions of which would be representative of other counties in the cut-over region.

Hubbard County seemed best to meet these conditions, because it is apparent that Aitkin, Carlton, Cass, Clearwater, Crow Wing, and Hubbard counties are a representative group of counties, their natural resources and economic conditions being in many ways similar.

Furthermore, Hubbard County is one of the smallest of the counties included in this group, as well as one of the smallest counties in the cut-over region. At the outset it appeared possible to complete the detailed Land Economic Survey of Hubbard County with the funds available, while it was apparently impossible to complete a survey of one of the larger counties.

Other reasons also influenced the selection of Hubbard County for study. Chief among these was the fact that Hubbard County represents a variety of economic and physical conditions. In certain parts of the county agriculture is highly developed; in other parts splendid second-growth forests exist, and in still other parts there is neither agricultural development nor young forests. The recreational industry is also well developed; there are numerous resorts, and Hubbard County has long been regarded by sportsmen as one of the better hunting and fishing areas of the state.

THE USES TO BE MADE OF THE LAND ECONOMIC SURVEY

The findings of the Land Economic Survey of Hubbard County are an adequate basis for directing the future development of the county. Sufficient data concerning both the physical and economic status of the county are now available to permit public officials to direct intelligently and to control wisely the future development of the county. At least one of the causes of the present distress of nearly all cut-over areas is the lack of adequate planning and uncontrolled development. Because of this, large sums of money have been spent unwisely, to make unnecessary and unsound public improvements; agriculture has been attempted, with the attendant human and social losses, where agriculture was bound to fail; and the productive capacity of the forest has been greatly reduced and the cost of forest rehabilitation greatly increased through uncontrolled and unrestricted cutting. All this is the heritage of the present generation. Altho little will be gained by criticising past mistakes, much can be done to avoid serious and less excusable future mistakes.

One of the factors of great importance in determining land use is the character of the soil. The nature of the soil and the climate, together with geographical location, determine the crops that can be grown most economically. A study of the soil considers all its component layers. Soil texture determines by its moisture-holding capacity the crops that can be grown.

The stoniness of the surface soil may limit the use of land in two ways: by the cost of removing the stones and by the difficulty of cultivating stony soils economically. No hard and fast line can be drawn beyond which a stony soil cannot be utilized for agricultural crops. This is relative, depending upon the distance from markets and the returns that can be gotten from the various crops grown on such a soil.

Topography must also be considered in a soil study. It limits the use of land for agricultural crops insofar as it limits the use of farm machinery; also because of the fact that such soils often erode seriously when cultivated.

The cover type map is an accurate picture of land use in the county. It shows the areas covered by forest growth, the predominating tree species by three-inch-diameter classes, and the relative density of the forest. The cut-over and open areas, the burns, and the swamps are also shown on the cover map. The maps are true to scale, so that all of the type areas are shown in their proper relationships. The cover type map also shows the areas and locations of cultivated lands, pasture lands, both wild and plowable lands, and the apparently idle or abandoned land formerly cropped. Both the cover type map and the soil map show the location of the buildings, churches, stores, schools, cemeteries, and resorts. On these maps are also shown the true locations of the roads in the county, and the map legend shows the class of the road as graveled, graded, or merely a dirt road. The Land Economic Survey made its own maps of the lakes of the county, and their locations and sizes, as shown on these maps, are probably the most reliable information concerning them available for the county as a whole.

The cover type map should, therefore, be very useful to anyone contemplating the purchase of any lakeshore or resort property, or land for cabin sites. The maps were drawn by men actually on the ground. Not only were these mappers presumably unbiased, but, to insure reliable results, their work was continually checked by efficient supervisors.

Prospective settlers will find in the soil and cover type maps a reliable picture of the physical conditions of the county. Cultivated lands and occupied buildings are shown on these maps. The soil map shows the character of the soil and the lay of the land. The cover map shows whether the land was covered by a growth of aspen, jack pine, Norway pine, or brush, or if it is a natural meadow. Public improvements, such as roads, schools, and churches, are also shown on this map.

The growth studies and timber volume are important in deciding upon future forest policies. The data on timber volumes are given by tree species and by townships. The growth data indicate the forest productivity of the various soils and thereby indicate their relative values for this purpose.

The report may also be very helpful in determining the need for new roads, their general location, or the advisability of abandoning roads that have little use. It contains economic and physical data concerning Hubbard County that will assist public officials to segregate marginal and submarginal lands, and thus to prevent unwise agricultural development. It should also be very helpful in working out a system of zoning in the county. The report in itself cannot, of course, do these things; it can only supply the data.

II. GENERAL DESCRIPTION OF HUBBARD COUNTY[1]

Hubbard County is situated in the north central part of the state, about 200 miles northwest of St. Paul and 130 miles west of Duluth. It is just east of Lake Itasca, the source of the Mississippi River, and is bounded on the north by Beltrami County, on the east by Cass, on the south by Wadena and on the west by Becker and Clearwater counties. It is rectangular in shape, 42 miles from north to south and 24 miles from east to west, and includes 28 townships with a land area of 932 square miles or 596,480 acres. About 8 per cent of the total area is covered by lakes.

Physiography. The outstanding surface features of the county are the central ridge—a rugged morainic belt crossing the county from east to west near its center, the rolling till plain to the north, and the smooth outwash plain to the south. The central ridge is sharply rolling to very hilly, some hills with precipitous slopes rising as much as 100 feet above adjacent deep depressions. The till plain with heavy soils, north of the ridge, has a local relief ranging from 5 to 30 feet. South of the ridge the country smooths out first to rolling hills and still farther south to level plains. Most of the lakes lie in a belt of gravelly hills just south of the ridge. Peat bogs are numerous and extensive both north and south of the central ridge. The northern till plain is interrupted by a narrow sandy plain extending from Lake George northward to the county line, and in the most southwesterly township a small till plain is enclosed in the outwash plain.

Relief. The surface relief of the county, outside of the hilly morainic belt, ranges from nearly level to rolling. No pronounced terraces occur along the streams, except for a narrow flood plain in a few cases. Portions of Badoura Township and several of the northwestern townships are poorly drained and have a number of shallow lakes and many peat bogs. Most of the streams are small, meandering, and sluggish and have had little influence on the topography, the nature of the surface relief being determined by glacial agencies, no important changes having taken place since the retreat of the last ice sheet that covered the county.

Elevation. Most of the county lies between 1,200 and 1,500 feet above sea level, the highest point being in Lake Alice Township, at an elevation of 1,620 feet; the lowest, in Steamboat River Township, at about 1,300 feet. Park Rapids, which lies on the outwash plain, has an

[1] This chapter was prepared by P. R. McMiller, assistant professor of soils in the University of Minnesota.

elevation of 1,426 feet. Lake Itasca, which lies just to the west of the county, is 1,477 feet above sea level.

Drainage. The Mississippi River crosses the extreme northwest corner of the county, which drains directly into it, and with its tributaries receives the water from the entire county. The portion north of the central ridge drains to the north and east, and the remainder drains to the south through the Crow Wing River, the largest stream in the county, which rises in a spring-fed lake near Akeley. Some of the streams flow through bogs and have little or no well-defined channels, and many of the others, where not bordered by peat, are only a few feet below the adjacent upland. A few of the larger, rapidly moving streams have deeper channels, in some places as much as 10 to 20 feet below the general level.

Vegetation. Except for open areas of prairie in the southern part, near Hubbard and Park Rapids, most of the county was originally covered with coniferous forest, the prevailing trees being white, jack, and Norway pines. Hardwoods mixed with Norway and white pine occupied the central ridge and the till plains, and on the outwash plains in the southern part there was a generous scattering of oak among the pines. Parts of the peat were occupied by poor or fair stands of black spruce, tamarack, and white cedar, while the rest was covered with sedges or shrubs. The remaining forest cover has changed greatly, nearly all the merchantable timber having been removed and forest fires having swept over large areas. Jack pine has become predominant on areas formerly occupied by Norway pine and on much of the finer-textured soil aspen has replaced the original mixture of hardwoods and white pine.

Lakes. Hubbard County has within its borders about 140 lakes, covering approximately 80 square miles. The largest is Lake Plantaganet, near the northern boundary. Most of them lie in the southern half of the county. Nearly all have sandy bottoms and good beaches, providing desirable locations for the numerous summer cottages, hotels, and camps. At the time of the survey most of the lakes, except those that are spring-fed, were below their normal levels. Many depressions formerly occupied by shallow lakes were completely dry.

Fish are to be had in almost every lake. There is duck shooting in the fall, and deer are plentiful.

Climate. Warm, short summers with an abundance of sunshine and long cold winters with much snow are outstanding features of the climate of Hubbard County. At Park Rapids, with a record for 43 years, the annual rainfall has averaged 24.4 inches, and at Itasca State Park, with a record for 21 years, it has averaged 23.6 inches. In the

driest year, 1910, Park Rapids received only 14.3 inches, and in the wettest year, 1906, 39.0 inches. On the average, more than two-thirds of the precipitation is received during the spring and summer months. The annual snowfall averages about 40 inches, the greatest amount falling in January.

The warmest months are July and August; the coldest, January and February. Temperatures of 90° F. and above during the day are common in midsummer, but at night there is usually a drop of 10 to 20 degrees. The winters are characterized by cold clear days with spells of subzero weather.

The length of the growing season, or the period between the last killing frost in the spring and the first in the fall, averages 127 days at Park Rapids but only 95 days at Itasca State Park. The latter station lies at 1,500 feet, 73 feet higher than Park Rapids, and its shorter growing season may be attributed in part to the difference in altitude. At Park Rapids the latest killing frost recorded was on June 6, 1897, and the earliest on August 25, 1887. On the peat bogs, frost is likely to occur in any month of the growing season.

The prevailing winds are northwesterly, with low to medium velocity, highest in the spring. At times, on the more sandy soils, they damage newly planted crops where these are not protected by neighboring woods.

Table 1, compiled from the records of the weather station at Park Rapids, gives the more important climatic data.

Table 1

Normal Monthly, Seasonal, and Annual Temperature and Precipitation at Park Rapids (Elevation 1,426 feet)

	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year, 1910	Total amount for the wettest year, 1906	Snow, average depth
	° F.	° F.	° F.	inches	inches	inches	inches
December	11.4	54	—44	0.71	0.65	1.50	6.5
January	4.1	51	—47	0.68	0 60	1.36	7.0
February	8.0	52	—51	0.64	0.47	0.18	6.0
Winter	7.8	54	—51	2.03	1.72	3.04	19.5
March	22.9	80	—38	1.00	0.18	0.95	7.6
April	40.1	87	—8	1.92	2.79	2.37	5.5
May	52 2	92	17	2.80	0.75	5.36	0.8
Spring	38.4	92	—38	5.72	3.72	8.68	13.9
June	63.0	101	27	4.25	0.70	6.05	0.0
July	70 1	104	38	3.59	1.59	3.02	0.0
August	64.7	98	28	3.41	0.68	10.13	0.0
Summer	65.9	104	27	11.25	2.97	19.20	0.0
September	55.7	96	18	2.48	3.21	3.42	0.1
October	43.2	87	—3	1.83	1.93	1.42	1.9
November	26.6	67	—32	1.09	0.80	3.25	6.2
Fall	41.8	96	—32	5.40	5.94	8.09	8.2
Year	37.6	104	—51	24.40	14.35	39.01	41.6

Table 2 reports the precipitation at Park Rapids since observations were begun in 1885. The dates of the last killing frost in spring and the earliest in fall for the last 13 years at Park Rapids, Cass Lake, and Itasca Park are given in Table 3, and the length of the growing season at these three stations in Table 4.

Table 2

Precipitation at Park Rapids (Elevation 1,426 feet)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1885	0.82	0.07	0.70	2.32	1.31	7.57	6.19	1.32	2.26	0.20	0.69	0.22	23.67
1886	0.99	1.05	0.20	3.31	2.09	3.44	3.00	1.82	0.65	1.80	1.70	0.65	20.70
1887	0.89	0.65	0.38	1.43	2.54	5.51	3.80	1.25	1.40	1.89	0.35	1.90	21.99
1888*	1.16	0.28	1.67	1.79	2.66	10.23	5.63	0.94	1.48	2.37	0.70	0.22	29.13
1889*	0.97	1.09	0.93	1.96	1.20	1.63	4.58	3.81	2.89	0.34	0.92	1.12	21.44
1890*	0.63	0.95	0.63	1.20	3.43	5.01	5.29	2.29	3.44	2.59	0.41	0.17	26.04
1891*	0.42	1.35	1.41	0.94	1.13	3.57	5.23	3.07	3.43	0.84	0.60	2.09	24.08
1892*	0.35	0.69	1.65	2.62	6.10	2.07	3.26	3.78	0.80	0.18	1.49	0.21	23.20
1893	1.17	1.15	1.58	5.19	1.64	4.71	1.86	4.24	1.40	2.10	0.50	0.92	26.46
1894	0.67	0.42	1.73	4.45	4.42	2.42	0.34	0.96	1.59	4.14	0.70	1.13	22.97
1895	0.36	0.21	0.07	0.47	3.24	7.14	3.91	2.77	2.30	0.21	0.92	0.24	21.84
1896	0.92	0.45	1.62	4.94	5.70	4.63	1.89	2.89	1.89	1.76	2.65	0.71	30.05
1897	2.25	1.56	1.10	2.00	1.05	7.49	10.16	1.12	0.43	1.27	0.38	0.62	29.43
1898	0.12	0.70	1.51	0.96	3.47	4.17	5.67	2.85	1.60	1.65	0.53	0.37	23.60
1899	0.63	0.28	0.91	2.35	7.99	9.06	3.42	8.59	1.73	2.78	0.52	0.31	38.57
1900	0.32	0.41	1.03	1.10	0.21	0.79	6.31	9.55	4.34	2.99	0.73	0.48	28.26
1901	0.36	0.22	1.98	2.51	1.11	6.24	4.91	1.48	1.24	3.55	0.70	0.77	25.07
1902	0.48	0.62	1.12	1.79	6.22	2.88	1.92	3.61	0.90	2.36	1.27	0.96	24.13
1903	0.61	0.55	1.24	2.30	3.99	1.79	2.38	4.68	5.44	2.35	0.44	0.87	26.64
1904	0.30	1.46	1.71	2.30	1.70	3.05	2.42	1.70	4.60	1.72	0.17	0.64	21.77
1905	0.62	0.42	0.71	2.18	5.05	8.11	4.94	3.14	2.71	2.37	2.42	0.18	32.85
1906	1.36	0.18	0.95	2.37	5.36	6.05	3.02	10.13	3.42	1.42	3.25	1.50	39.01
1907	2.28	0.67	1.46	1.32	3.11	3.83	1.58	4.52	3.09	1.00	0.35	0.85	24.06
1908	0.27	1.55	1.66	1.05	3.82	4.17	2.40	2.25	2.99	0.83	1.07	0.69	22.75
1909	0.90	0.26	0.45	1.81	2.64	1.49	8.00	7.84	1.77	2.46	1.16	1 31	30.09
1910	0.60	0.47	0.18	2.79	0.75	0.70	1.59	0.68	3.21	1.93	0.80	0.65	14.35
1911	0.61	0.59	0.73	1.57	3.16	2.93	3.06	5.83	3.28	1.28	0.89	0.62	24.55
1912	0.31	0.24	0.24	1.24	4.16	1.31	3.71	3.88	3.50	0.51	0.49	0.79	20.38
1913	0.23	0.19	1.58	1.47	3.20	3.17	6.49	1.75	3.72	4.65	0.34	T.	26.79
1914	0.56	0.48	1.60	1.74	2.16	7.95	2.42	3.15	3.07	4.57	0.52	0.31	28.53
1915	0.71	1.19	0.25	1.01	3.90	9.53	2.98	1.27	2.54	1.70	1.28	0.69	27.05
1916	1.83	0.48	2.20	1.74	3.78	4.64	5.83	6.75	2.67	0.44	0.08	0.86	31.30
1917	0.48	0.85	0.92	2.06	0.19	2.35	5.06	1.13	2.98	1.72	0.13	0.73	18.60
1918	0.34	0.21	0.34	3.15	3.50	1.41	5.38	2.40	1.38	1.49	1.75	1.42	22.77
1919	0.23	0.71	0.71	1.68	2.85	6.98	6.08	4.29	1.24	2.57	2.18	0.35	29.87
1920	0.86	0.29	1.07	1.34	3.37	5.66	3.17	1.10	3.94	0.85	0.56	0.68	22.89
1921	0.43	0.47	1.55	2.87	4.21	5.23	3.37	3.23	3.13	0.75	0.30	0.69	26.23
1922	0.35	1.67	1.14	3.14	2.37	2.93	0.74	1.42	2.88	0.46	4.34	1.03	22.47
1923	0.71	0.77	0.42	1.89	1.28	7.28	2.68	1.30	1.92	0.52	0.39	0.47	19.63
1924	0.20	0.29	0.38	2.02	2.26	4.17	2.50	3.58	3.15	1.32	0.34	0.36	20.57
1925	0.25	0.54	0.72	2.43	1.74	7.24	2.19	3.69	4.04	1.18	0.81	0.27	25.10
1926	0.47	0.57	0.62	0.08	1.73	1.99	1.36	3.22	2.67	3.57	1.03	0.78	18.09
1927	0.91	1.02	1.04	1.91	3.14	2.38	2.46	1.73	2.56	1.42	1.24	1.11	20.92
1928	0.28	0.10	0.95	1.38	0.64	3.36	4.60	7.12	3.28	2.09	0.47	0.73	25.00
1929	0.88	0.30	0.92	0.92	1.43	0.55	1.35	2.17	1.67	2.47	1.05	0.90	14.61
1930	1.26	2.03	1.05	0.68	3.99	2.89	1.39	2.34	0.45	1.48	3.08	0.60	21.24
1931	0.19	0.60	1.08	0.37	1.68	4.92	4.10	4.64	1.41	1.28	2.38	0.80	23.65
1932	1.19	1.25	1.41	2.39	4.56	3.65	1.94	3.70	1.30	1.64	1.15	0.25	24.43
1933	2.00	1.10	3.60	1.86	7.51	1.56	1.09	0.89	2.24	1.60	2.04	3.16	28.65
Average	0.70	0.66	1.00	1.98	2.92	4.35	3.55	3.43	2.46	1.83	1.07	0.71	24.66

* From record for Leech Lake Dam stations, no observations for the period having been made at Park Rapids.

Table 3

Dates of Last Killing Frost in Spring and Earliest in Fall in or Near Hubbard County

Year	Park Rapids		Cass Lake		Itasca State Park	
	last	first	last	first	last	first
1921	June 4	Sept. 30	May 17	Oct. 7	June 4	Sept. 12
1922	May 28	Oct. 9	Apr. 28	Sept. 25	May 29	Sept. 10
1923	May 17	Sept. 13	May 17	Sept. 13	May 22	Aug. 24
1924	May 25	Sept. 29	May 25	Sept. 29	June 7	Aug. 16
1925	May 25	Sept. 21	May 25	Sept. 21	June 10	Sept. 12
1926	May 22	Sept. 24	May 22	Sept. 12	June 18	Sept. 11
1927	May 5	Sept. 23	June 14	Sept. 26	June 5	Sept. 18
1928	May 3	Sept. 23	June 4	Sept. 24	June 14	Sept. 23
1929	May 3	Sept. 5	June 3	Sept. 18	June 7	Sept. 5
1930	May 24	Sept. 28	May 24	Sept. 19	May 30	Sept. 28
1931	May 8	Aug. 30	May 25	Aug. 24	May 31	Aug. 30
1932	May 27	Sept. 27	May 6	Oct. 9	May 28	Sept. 6
1933	May 10	Sept. 26	May 31	Sept. 26	June 13	Sept. 26
Earliest	May 3	Aug. 30	Apr. 28	Aug. 24	May 22	Aug. 16
Latest	June 4	Oct. 9	June 14	Oct. 9	June 18	Sept. 28

Table 4

Length of Growing Season in and Near Hubbard County

Year	Park Rapids	Cass Lake	Itasca State Park
	days	days	days
1921	117	143	100
1922	133	150	104
1923	119	119	76
1924	127	127	68
1925	119	119	94
1926	130	113	85
1927	141	104	105
1928	143	112	101
1929	125	107	90
1930	126	127	120
1931	112	90	90
1932	112	155	100
1933	138	117	104
Average	126	122	95

Table 5

Mean Annual Temperature

	Park Rapids	Itasca State Park
	° F.	° F.
December	11.3	11.3
January	4.1	2.3
February	7.5	8.7
Winter	7.6	7.4
March	22.8	22.2
April	40.0	40.1
May	52.3	51.8
Spring	38.4	38.0
June	62.8	61.1
July	67.9	65.9
August	64.6	62.7
Summer	65.1	63.2
September	55.6	54.7
October	43.1	43.2
November	26.4	27.8
Fall	41.7	41.9
For the year	38.2	37.6

Length of record at Park Rapids, 43 years.
Length of record at Itasca State Park, 21 years.

Table 6
Mean Annual Precipitation

	Park Rapids	Itasca State Park
	inches	inches
December	0.72	0.91
January	0.69	0.67
February	0.61	0.60
Winter	2.02	2.18
March	0.99	0.84
April	2.00	1.69
May	2.90	2.36
Spring	5.89	4.89
June	4.40	4.05
July	3.66	2.95
August	3.42	3.14
Summer	11.48	10.14
September	2.55	2.54
October	1.86	1.77
November	0.98	0.89
Fall	5.39	5.20
For the year	24.78	22.41

Length of record at Park Rapids, 43 years, elevation 1,426 feet.
Length of record at Itasca State Park, 23 years, elevation 1,500 feet.

Table 7
Occurrence of Killing Frosts in Spring and Fall

Year	Park Rapids (Elevation 1,426 feet)			Year	Itasca State Park (Elevation 1,500 feet)		
	Last in spring	First in fall	Length of growing season, days		Last in spring	First in fall	Length of growing season, days
1885	May 18	Aug. 26	100				
1886	May 16	Aug. 31	107				
1887		Aug. 25					
1893	May 25	Sept. 23	121				
1894	May 19	Sept. 11	115				
1895	May 21	Sept. 23	125				
1896	May 18	Sept. 19	124				
1897	June 6	Sept. 17	103				
1898	May 11	Sept. 10	122				
1900	May 4	Sept. 17	136				
1901	May 25	Sept. 18	116				
1902	May 11	Sept. 12	124				
1903	May 7	Sept. 17	133				
1904	May 15						
1905	May 28	Oct. 11	136				
1906	May 9	Sept. 27	141				
1907	May 27	Sept. 22	118				
1908	May 7	Sept. 28	144				
1909	May 10	Oct. 11	154				
1910	May 13	Sept. 9	119				
1911	May 12	Sept. 25	136	1911	May 29	Sept. 12	106
1912	May 16	Sept. 26	133	1912	June 7	Sept. 26	111
1913	May 10	Sept. 21	134	1913	June 9	Sept. 21	104
1914	May 12	Sept. 25	136	1914	May 23	Sept. 25	125
1915	May 18	Oct. 5	140	1915	June 9	Aug. 26	78
1916	May 19	Sept. 15	119	1916	June 2	Sept. 16	106
1917	May 27	Sept. 10	106	1917	June 15	Sept. 9	86
1918	May 20	Sept. 4	107	1918	May 22	Sept. 4	105
1919	May 8	Oct. 7	152	1919	June 2	Sept. 24	114
1920	May 14	Sept. 30	139	1920	June 3	Aug. 21	79
1921		Sept. 30		1921	June 4	Sept. 12	99
1922	May 28	Oct. 9	133	1922	May 29	Sept. 10	104
1923	May 17	Sept. 13	119	1923	May 22	Aug. 24	94
1924	May 25	Sept. 29	127	1924	June 7	Aug. 16	70
1925	May 25	Sept. 21	119	1925	June 10	Sept. 12	94
1926	May 22	Sept. 24	125	1926	June 18	Sept. 11	85
1927	May 5	Sept. 23	141	1927	June 5	Sept. 18	105
1928	May 3	Sept. 23	143	1928	June 14	Sept. 23	101
1929	May 3	Sept. 5	125	1929	June 7	Sept. 5	90
1930	May 24	Sept. 28	126	1930	May 30	Sept. 28	121
1931	May 8	Aug. 30	113	1931	May 31	Aug. 30	90
1932	May 27	Sept. 17	113	1932	May 24	Aug. 28	96
1933	May 22	Sept. 16	117	1933	May 28	Sept. 6	100

III. HISTORY OF HUBBARD COUNTY[1]

EARLY SETTLEMENT

Perhaps the first white man to traverse what is now known as Hubbard County was Henry R. Schoolcraft.[2] Early in 1832 he was authorized to proceed into the Lake Superior and Mississippi River country to discourage the immemorial warfare between the Chippewa and Sioux Indians. About July 10, 1832, he reached Cass Lake. Here he engaged the services of an Indian guide, Ozaconidib or Yellow Head, who collected equipment and men for an expedition to explore the source of the Mississippi River. The next day the expedition proceeded up the river, through Lake Bemidji, up the Yellow Head or Schoolcraft River, and after a portage of six miles over sand ridges, beheld Lake Itasca, so named by Schoolcraft as the "true head" of the Mississippi.

On the return journey from Cass Lake, Schoolcraft crossed Leech Lake and after two portages followed a chain of small lakes to the southwest and reached the headwaters of the Crow Wing River. Thus Schoolcraft crossed the northern and southeastern parts of the county in 1832.

The government survey in the county was begun in 1860 and completed in 1879.[3] The first survey of township lines was made in 1860 in nine townships. The rest of the 28 townships had the town lines run at various times from 1861 to 1878. The first subdivision lines were run in Hubbard and Henrietta townships in 1860, and they were the first townships to be completely surveyed. Straight River Township was completed in 1861 and Todd Township in 1871. The last subdivision lines were run in Schoolcraft and Lake Hattie townships in 1879.

The depression of the seventies caused search for "some spot, some valley in the west, where free from toil and pain, the wearied soul might rest."[4] Rumors of the existence of prairies in that section of Minnesota were responsible for directing early settlement to Hubbard County. Joe Sombs, a timber cruiser, discovered Hubbard Prairie, or First Shell Prairie, about 1878. Henry Vale and James Campton were the first bona fide settlers and came from Ohio to Verndale by train and then by team to their claim in the southwest quarter and northwest quarter of Section 28 in Hubbard Township in April 1879.[5] Miles Sanford settled in Section 26 later in 1879, coming in search of Paddoch's

[1] This chapter was prepared by D. C. Dvoracek and Raymond Stevens.

[2] Folwell, W. W., "A History of Minnesota." Vol. I, p. 114.

[3] Original township plats—Surveyor General's Office, St. Paul, Minn.

[4] Walling, P. A., "History of Hubbard County." Park Rapids Enterprise, February 16, 1923 to April 16, 1923.

[5] Benham, Howard, Hubbard, Minnesota.

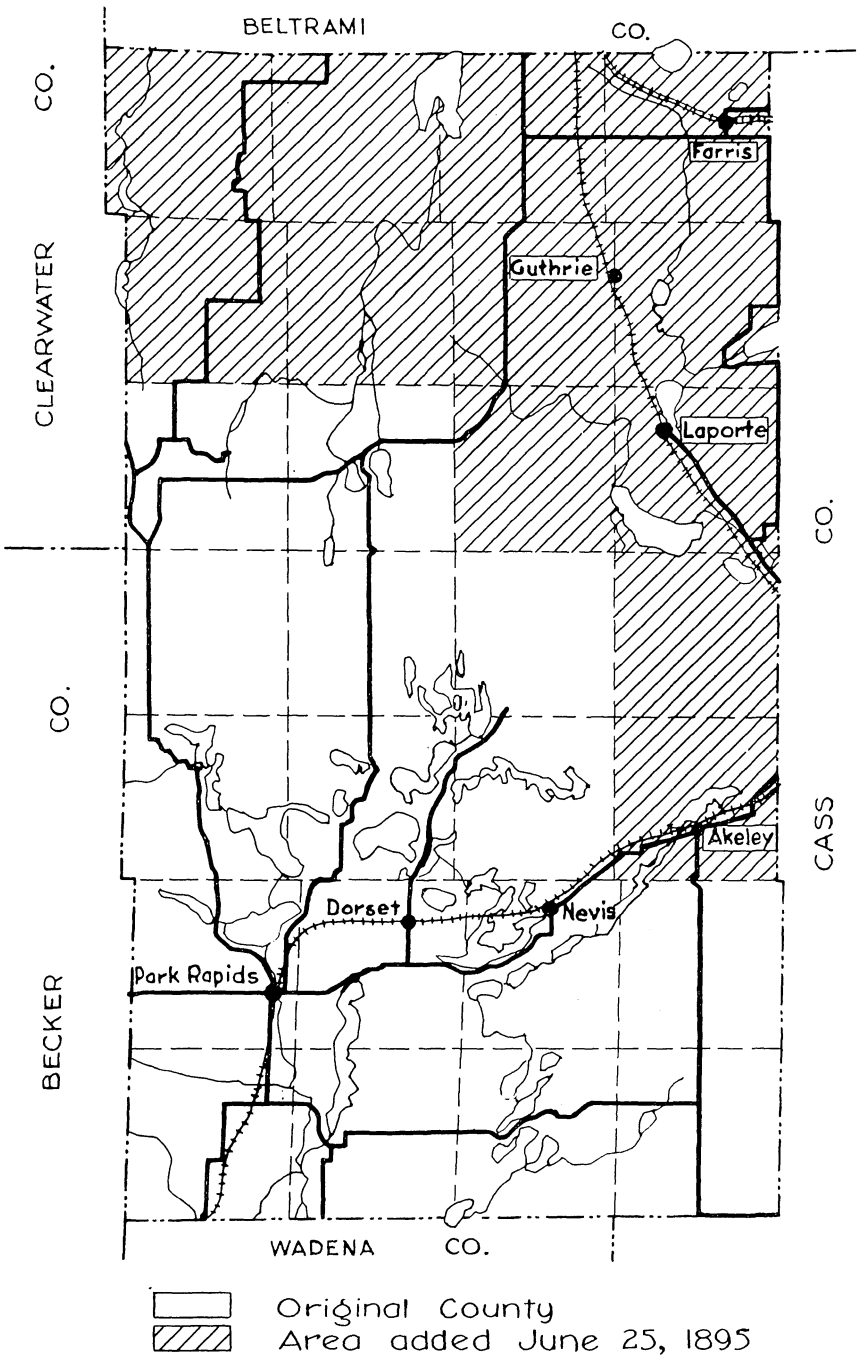

Fig. 1. The Original Area of Hubbard County and the Area Added June 25, 1895 (The added area is shaded)

Valley near Perham. Hubbard Prairie was settled first, Second Shell Prairie in Todd Township was settled next, and Third Shell Prairie, or Osage Prairie, last. Most of the first settlers came from Iowa and neighboring states. The comparative openness of these prairies no doubt was responsible for the early development.

The early settlers[6] say that nearly all of Hubbard Township and part of Henrietta Township were open prairies, with scattering clumps or strips of jack pine and some Norway pine. They believe that originally all of the prairie grew timber which was probably blown down and later burned. Prior to settlement, the Indians ran fires annually over these prairies to improve the grass for deer. Pine knots were ploughed up on this prairie when it was first broken. Present pine groves have grown voluntarily since 1880. The Second Shell Prairie was more open, with scattering jack pine and Norway pine.

Many of the first settlers of the northeastern part of the county came from Red River Valley points such as Hendrum, Halstad, and Shelley, in the late eighties and early nineties.[7] They came primarily as hunters, with no definite intention to farm. They worked each fall in the harvest fields of the Dakotas.

The first settlers of the northwestern part of the county came in the late nineties and had no common origin. Some came from southwestern Minnesota, some from eastern Canada, and some came over from around Park Rapids.[8] It is thus evident that no one nationality predominated in the settlement of Hubbard County, and the early population was largely native-born of mixed nationality and remains so to this day.[9] The census for 1910 gives 81.7 per cent of the population as native-born and only 17.3 per cent as foreign-born.

James Campton[10] was the first farmer to sow a crop. In the fall of 1879 he seeded 15 acres of fall rye. Potatoes and rutabagas were planted on the new breaking. Some crops were grown for household use, but most of the cultivated land was sown to grains, particularly wheat and oats, and sold as cash crops. At that time, wheat sold in Park Rapids for 37 cents a bushel.[11]

Potato growing was considered beneath the dignity of real farmers. The climate was considered too cold for livestock. Salt pork and potatoes were bought instead of being produced at home. Their farming methods, likewise, were rather superficial. Better farming methods were introduced later by farmers coming in from older settled states.

[6] Sanford, Fr., Hubbard, Minnesota.
[7] Nygaard, M. M., Park Rapids.
[8] Olson, C. A., Becida, Minnesota.
[9] Walling, P. A., "History of Hubbard County," Park Rapids Enterprise.
[10] Ibid.
[11] Ibid.

The first post office for this settlement was located where the old Verndale trail crosses Shell River and in 1880 was called Shell City, or "Post of the Prairies." J. M. Yoder was the first postmaster and operated a store in connection with the post office. About the same time,[12] April 1880, Jarvis Howard and a Mr. Katzky established a trading post at Manter, later known as Hubbard. A little later a store and post office were established at this point by Jarvis and Ramsey.

The location of a mill site on Fishhook River in 1880 by the Rice Brothers and the erection of a saw and grist mill was the beginning of Park Rapids. Prior to this, the nearest mills were at Verndale and Wadena. On July 4, 1881, Park Rapids was named by Frank C. Rice, the owner of the townsite, the name being suggested by the park-like groves in the prairies and the rapids in the Fishhook River, undammed at that time. In the fall of 1890, the village limits were marked out to include sections 23, 24, 25, and 26 of Todd Township. A village election was held in December of that year.

Hubbard County was established by the legislature in response to a petition and the bill was passed February 26, 1883.[13] It was named in honor of J. F. Hubbard, Governor of Minnesota from 1882 to 1887. Sixteen townships were set aside from Cass County and named. These townships composed the original county. Park Rapids was designated as the temporary county seat. In 1888, Hubbard County was detached from Crow Wing County for judicial purposes, and a court was established at the county seat.

On August 3, 1889, bonds for $1,000 were voted to build a courthouse at Park Rapids. In 1895, the matter of squaring the county was presented to the legislature and an enabling act was passed, providing it was the desire of 55 per cent of the resident voters. This wish was expressed by vote and 12 townships were added to the northern part of the county, making the present 28 townships.

The first school in Hubbard County was established in 1882 and was known as the Pioneer School. It was supported by public subscription. As soon as the county was established, a school was organized at Park Rapids, with Mary Sartin as the first teacher. District No. 2 was organized at about the same time at Hubbard. A. A. True was the first county superintendent of schools. The present Park Rapids school site was deeded in 1886 and $4,000-bonds were voted to build a three-room building, which was completed in 1887. Rural school districts were organized before the number of pupils justified it. This was sometimes done to get the tax before the timber on which the tax was levied was cut and removed.

[12] Benham, Howard, Hubbard, Minnesota.

[13] Minnesota Historical Society Collections. Vol. XVII, p. 242.

The first settlers had to cut their own roads and build their own bridges or ford streams to reach their destinations. Naturally, they chose the path of least resistance. This resulted in the winding trails which persist to this day. Perhaps the first government trail[14] entered the county from the east, to the east end of Elbow Lake, passed along its south shore, then along the south shore of Fishhook Lake to the south quarter post of section 15, Todd Township, and then to the west line of the county and to the White Earth Reservation. The first load taken into the northwestern part of the county by C. A. Olson in 1899 took four days from Hay Creek to Becida, a distance of about 27 miles. In 1900 it still took three days to haul a load from Park Rapids to Becida. Roads laid out on section lines were started about 1883, or shortly after the county was established. The first bridge across Fishhook River at Park Rapids was built in 1885 and was financed by private subscription. Prior to this time, the stream was forded below the mill dam. Settlers coming to Park Rapids from Hubbard forded what is now Long Lake, about a mile south of the present Trunk Highway. When a mill dam was put in at Hubbard, at the lower end of Long Lake, raising the lake level eight feet, this line of communication was cut off. In 1890 a road was made more readily passable from Wadena to Park Rapids and the mail service was shifted there from Shell City.

The establishment of Itasca Park in 1891, and its attraction for tourists, made it necessary in 1900 to build and maintain better roads from Park Rapids, which became a gateway for tourist traffic to the lakes to the north. The Jefferson Highway and the Scenic Highway were laid out in 1901. The Lake George road from Park Rapids was laid out and cut out about 1912-13. Prior to this time supplies for Bemidji, which was established about 1896, were freighted from Park Rapids over the old Park Rapids–Bemidji trail.

In 1881 a post office was established at Park Rapids, with F. C. Rice as postmaster. It depended on volunteer service for its weekly mail from Shell City. In the spring of 1883, a regular mail route was extended from Shell City to Park Rapids. In July, 1886, daily mail service from Verndale was initiated. In 1892, a star route was established from Park Rapids to Osage. The first rural free delivery mail route was started from Hubbard in 1895.

RAILROAD DEVELOPMENT

A gesture at building a railroad was made in 1882[15] when a party of surveyors came through, laying out a right-of-way ostensibly for the Great Northern Railway. Nothing came of this, however. About 1884

[14] Walling, P. A., "History of Hubbard County."
[15] Walling, P. A., "History of Hubbard County."

a company known as the Wadena and Park Rapids Railroad Company was organized, and a preliminary survey was made. The track was laid and the first excursion train was scheduled to arrive at Park Rapids on August 1. Regular mixed trains were scheduled to run from Park Rapids as far as Eagle Bend three times a week. About 1891, track was laid to Akeley and Cass Lake. Boom times immediately followed the building of railroads. Building was overdone for the time being, and depression followed. The first telegraph message was sent from Park Rapids on September 15, 1891.[16] The first train to carry passengers to reach the northern end of the county was run from Fosston to Cass Lake September 26, 1898, by the Great Northern Railway. The Northern Pacific started work there in 1898 and finished the track from Walker to Bemidji in 1899. It reached Walker from Brainerd in 1897. It served as a logging road at first, but when it was extended to Bemidji it became a common carrier.

An attempt at water transportation was made at Shell City in 1884, when a power boat known as the Lottie Lee was built. An attempt was made to run an excursion in August, but it encountered difficulty and the boat was later sold and was used on the Mississippi River.

Few meetings of any kind were held in the early years, except occasional prayer meetings held by itinerent preachers. Some irregular church services were held in 1883, and a Sunday School was organized the same winter. The Congregational Society was the first to erect a church at Park Rapids. About 1885, during the building boom, the Methodist and Catholic churches were built.

In July, 1882, H. R. Cobb started publishing the Park Rapids Enterprise, presumably the first newspaper published in the county. The Bulletin appeared later at Hubbard. The Farmers Alliance published its Advocate. The Clipper also appeared at Park Rapids and was later sold and became the present-day Journal.

INDUSTRIAL DEVELOPMENT

Industrial development in Hubbard County consisted largely in the development of the sawmill industry. As early as 1860, due perhaps to the first government surveys which were made at that time, lumbermen were aware of the existence of extensive stands of white, Norway, and jack pine in Hubbard County. Beginning in about 1870, large tracts of timberland were acquired by lumbermen under the operation of the Homestead Act of 1862. This was done by purchasing the homestead rights of soldiers, or their heirs, for $100 and later using this script to

[16] Ibid.

file on lands. A large area of timberland was also acquired by lumbermen at an auction of government land held at St. Cloud, Minnesota.

The first logging camp[17] to be operated in Hubbard County was located on Palmer Lake and operated by H. B. Monson during the winter of 1879-80. The logs were cut and floated down the Crow Wing River to Motley, where they were sawed. During the winter of 1881-82, a logging camp was operated on Portage Lake, north of Park Rapids, and another one was operated in Straight River Township.

The Red River Lumber Company drove the piling for a sawmill on Upper Crow Wing Lake in 1890, at what is now the village of Akeley. Mill construction, however, was not started until September 30, 1898, and cutting began in May 1899. This mill, a double band, had a capacity of 375,000 board feet in 20 hours. Until 1904 or 1905 only the best white and Norway pine trees were cut. The top cutting diameter at that time was eight inches. After 1905 jack pine was cut also, and the minimum top diameter was reduced from eight to six inches. This mill was burned in November 1909, but was replaced by a mill purchased at Scanlon, Minnesota. This mill began operation in May 1910 and had a capacity of 500,000 board feet in a 20-hour day. When running at capacity output, the mill had a monthly payroll of $50.000.

When the Red River Lumber Company began operation at Akeley, the timber naturally was cut near the mill site first. The logs were hauled by sleigh in what is now the Eleventh Crow Wing Lake from the northern part of Akeley Township and from the district of Steamboat River, which adjoins it to the north. The company at first had 4 to 5 logging camps, but after 1908 it had 8 to 10 camps with 4,000 to 5,000 men on the woods payroll. During the peak of operations, the woods payroll was approximately $60,000 a month during the winter. This was about one-third more than the summer payroll.

When the mill had cut the timber in its immediate vicinity, the company built a standard gauge logging railroad into its holdings. The logging road joined the Great Northern Railway near the range line in the southwestern corner of Akeley Township. From there it extended in a northerly and southwesterly direction as the timber was cut. This logging railroad was started in 1902. In 1903, it had reached the Sheridan Lake country in Hendrickson Township and also the west shore of Lake George in Lake George Township. By 1915, the railroad had been extended to Lake Alice Township on the west side of the county and to within a quarter of a mile of Itasca State Park. The company employed 3 to 4 train crews, or about 40 to 50 trainmen, including the watchmen, the repairmen, tank men, and 25 to 30 section men.

[17] Sanford, Fr., Hubbard, Minnesota.

The Red River Lumber Company mill at Akeley shipped approximately 30 carloads of lumber a day. Winter shipments were approximately one-third of summer shipments. The record shipment for one day was 43 carloads of lumber. The products were sold throughout the middle west and east. Shipping of lumber continued from Akeley about a year after the mill closed, the last shipments being made in December 1916.

The Red River Lumber Company's mill finished cutting in September 1915. The mill was dismantled in 1918, the steel in the logging railroad having been taken up in 1917.

Many smaller mills operated in different parts of Hubbard County from time to time.

Ellersick & Sons built a single circular sawmill at Park Rapids in 1892-93. This was converted to a band mill in 1897, and the mill capacity was raised to about 50,000 feet in a 10-hour day in 1902. It was sold to the Park Rapids Lumber Company.

In 1895 a company of loggers, organized under the name of the Minnesota Logging Company, built the Brainerd and Northern Logging Railroad from Brainerd to Leech Lake and beyond. Their operations continued until about 1904. This company operated in a part of Steamboat River Township.

During the autumn of 1898, Pete McGuire built a sawmill on Wolf Lake in Farden Township. This mill had an annual output of from 250,000 to 1,250,000 board feet. The average cut was probably around 500,000 board feet a year.

Dan Petrie had several mills in Hubbard County from time to time. His operations began at Hubbard in 1887. This mill had a capacity of 7,000 board feet a day. In 1896 and 1897 he operated another mill of about the same capacity on Ogilvie Lake in Badoura Township. In 1901 and 1902, Petrie built three sawmills and a lath mill on the south shore of Lake Ida in Lake Emma Township. The sawmills cut from 10 to 12 thousand board feet a day and the lath mill from 35 to 40 thousand laths. Between 1897 and 1902, Petrie also operated a sawmill on the east end of Lake Belletain near the village of Nevis.

A large number of smaller mills operated in the county from time to time. Some of these small sawmills would move in to cut an area as small as 40 acres. Such mills had crews of from three to five men. The operations of these mills were intermittent, as they cut for local consumption only. The average daily cut probably did not exceed 8,000 board feet.

About 1907 or 1908, a large number of portable mills began cutting second-growth jack and Norway pine into laths. However, the lath

mills stopped operations abruptly in 1928, when building declined and the supply of laths exceeded the demand.

At the present time there are very few areas of merchantable timber left in the county, and because of the unfavorable lumber and lath market there is practically no activity of any kind in the lumber-milling business. The lumber exports from the county have been decreasing steadily for a number of years.

POPULATION TRENDS AND POPULATION DENSITIES

Hubbard County is listed in the United States Census for the first time in 1890, having been organized in 1883. Its total population was 1,412 in the 16 townships included at that time. This population was distributed as follows: Crow Wing Lake, 90; Hubbard Township, including the village of Hubbard, 533; Straight River Township, 157; Todd Township, including the village of Park Rapids, 415, and the precinct of Elbow Lake, 217, including eight townships in the northern part of the county. In 1900 the population of the county had increased to 6,578, or 366 per cent. This was again increased to 9,831, or 49 per cent, by 1910, and 10,136 by 1920, a slight increase of 3 per cent. The census of 1930 shows a decline of 5 per cent, or a population of 9,596. The rapid increase in population from 1890 to 1910 may be attributed to the opening of public lands to homesteading, resulting in a rapid increase of settlers, and to the development of the timber industry, which reached its peak by 1910 and declined by the time of the census of 1920. The population of the county distributed by townships and villages and by census periods is shown in Table 8. The population per square mile is also shown.

The density of population (number of inhabitants per square mile of land area) varies from less than 1 in Steamboat River District to 13 in Henrietta Township, and the density for the county, including all villages, is 10. These figures are not an exact representation of the density of farm population in all townships, as in some towns unincorporated village population is included, as Dorset in Henrietta Township, Hubbard in Hubbard Township, and Guthrie in Guthrie Township. In others, incorporated villages are listed separately. The inclusion of populations of unincorporated villages would not be particularly significant except in the case of Guthrie. Omitting the population of the incorporated villages of Park Rapids, Akeley, Nevis, and La Porte, and ignoring the slight error of not omitting the land included in these villages, the average density of rural population for the county is 7.0 per square mile.

Table 8

Population of Hubbard County by Civil Divisions

Civil divisions	Population by decades			Population density per square mile
	1910	1920	1930	1930
Hubbard County*	9,831	10,136	9,596	10.28
Akeley Township	2,574	480	360	10.5
Akeley Village	....	855	514	...
Arago	135	183	205	6.5
Badoura	165	281	223	6.3
Clay	58	44	73	2.1
Clover	61	99	103	2.9
Crow Wing	156	157	159	5.2
Farden*	215	255	279	8.3
Fern	212	234	216	6.7
Guthrie	83	238	386	10.9
Hart Lake	190	368	368	10.9
Helga*	166	322	350	10.4
Hendrickson	149	174	115	3.2
Henrietta	369	467	426	13.0
Hubbard	424	500	435	12.9
Lake Alice	62	64	98	2.9
Lake Emma	216	232	197	7.1
Lake George	117	140	187	5.5
Lake Hattie	68	138	139	4.2
Lakeport	109	249	252	8.3
La Porte Village	140	216	185	...
Mantrap	160	253	197	6.3
Nevis Township	284	400	299	10.3
Nevis Village	238	412	275	...
Park Rapids	1,801	1,603	2,075	...
Rockwood	198	226	214	6.4
Schoolcraft	79	86	126	3.7
Straight River	342	403	398	11.4
Thorpe	110	85	59	1.7
Todd	347	408	356	11.0
White Oak	247	463	297	8.6
Steamboat	21	17	22	0.6

* County totals for 1920 and 1910 include population (84 in 1920 and 143 in 1910) of Farris Village, disincorporated in 1929 and annexed to Farden Township; county total for 1910 also includes population (134) of a part of Chippewa Indian Reservation, lands allotted to Indians, and population (49) of Nary Village, annexed to Helga Township between 1910 and 1920.

A comparison and study of trends of percentage changes of population taking place in the various townships suggest the possibility of grouping some of the townships which have similar trends of population change and are somewhat similar as to location and soil characteristics. It appears that the various factors effecting population change had somewhat similar effects on the population within these various groups.

The population change trends of Group 1, which includes Straight River, Hubbard, Henrietta, Todd, Crow Wing, and Arago townships, are shown in Figure 2.

The general tendency for this group, especially after 1910, appears to be to maintain a more or less stationary population. The exception in this group is Arago Township with a density of 6.5, which may be considerably below that of other townships of the group and hence may be considered as being less near the saturation point for population under present economic conditions. The population density in this group ranges from 6.5 to 13.0 and the average density is 10.1, the highest of all groups.

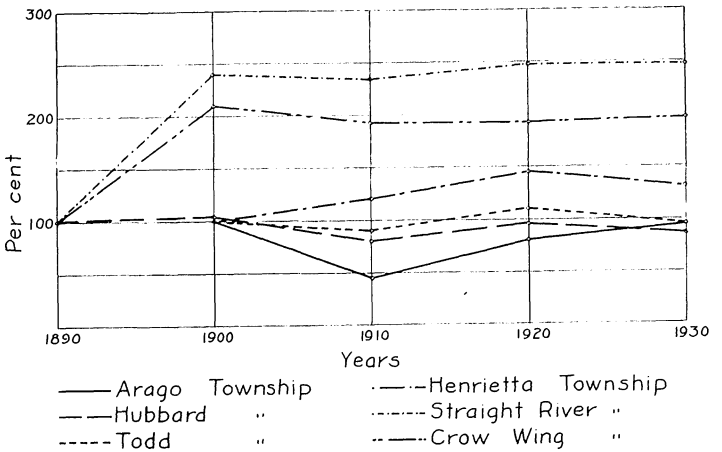

Fig. 2. The Percentage Change in Population of Townships in the Straight River Group

The population change trends in the Guthrie group of townships, including Guthrie, Helga, Hart Lake, Lake Port, and Farden, are shown in Figure 3. In this group there is a distinct tendency toward a steady increase in population. The increase in this group is not parallelled by any other group. The average population density is 9.8 per square mile, or only 0.3 lower than that of Group 1, and the range is 8.3 to 10.9. This trend of population increase, together with the already relatively

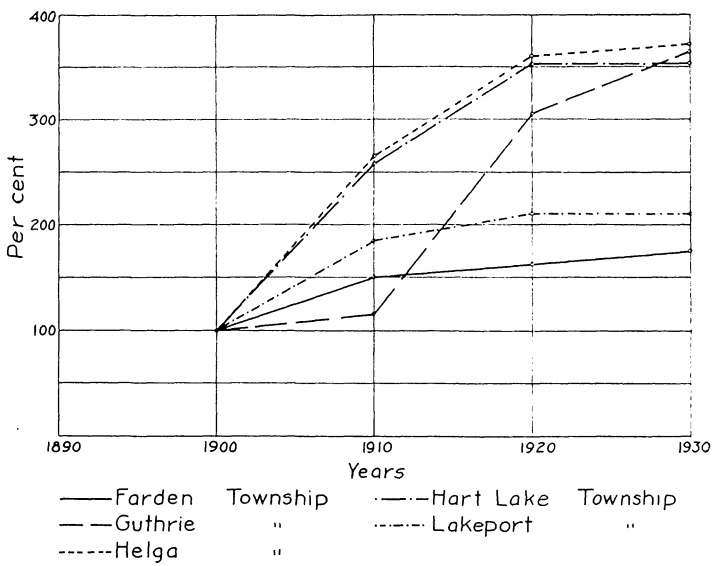

Fig. 3. The Percentage Change in Population of Townships in the Guthrie Group

high population density, may indicate a relatively high capacity to absorb or attract population. In general this trend may indicate that this group of townships has relatively higher development possibilities than any other group in the county. Farden Township seems to be the exception, its trend of population change being much more gradual and having started from a higher base population because of the inclusion of the Village of Farris. Its population density of 8.3 is the lowest of this group of townships. It may not have equal capacity for population because of the light soil area in the northeast corner of the township.

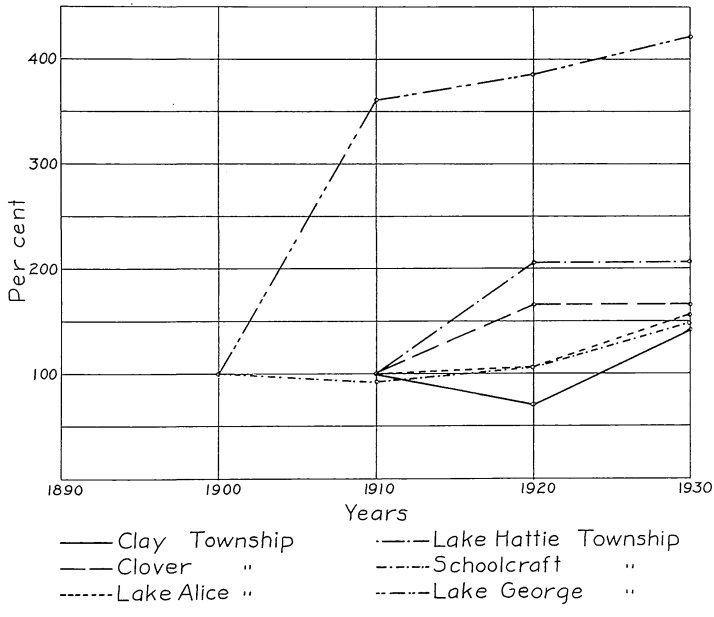

Fig. 4. The Percentage Change in Population of Townships in the Lake George Group

A similar trend in population is seen in the Lake George group, Figure 4, including Lake Hattie, Clover, Lake Alice, Clay, and Schoolcraft townships. All of these townships except Clay and Schoolcraft showed an increase in population in the 1920 census, and all, without exception, showed some increase in the last decade. The increases, tho much smaller for the whole period, compare favorably with those of Group 2 during the last decade. It must be borne in mind, however, that the trends start from a much lower base and hence are not as significant as might at first appear. Lake George Township is somewhat out of the ordinary in showing a marked percentage change from 1900 to 1910, due to a relatively smaller population in 1900 than the other townships. The population density in this group of townships ranges

from 2.1 to 5.5, and the average density is 3.8, much lower than the two preceding groups. This fact with a lower rate of population increase may suggest that this group of townships with its relatively low population density is nearer its saturation point for population than is the preceding Guthrie group with a density of 9.8.

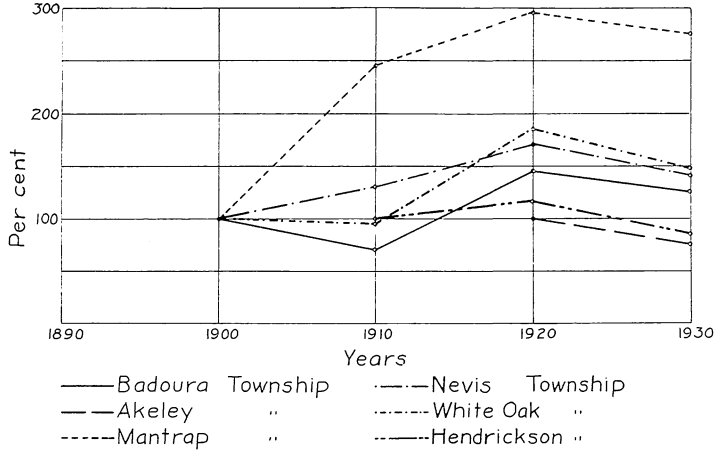

Fig. 5. The Percentage Change in Population of Townships in the Nevis Group

Group 4, or the Nevis group, composed of Mantrap, White Oak, Nevis, Badoura, Hendrickson, and Akeley townships, shows a somewhite different trend of population change. As shown in Figure 5, since 1900, the general tendency was for a steady population increase until 1920. Since 1920, there has been a marked decline in population in every township, and the decline is more pronounced than in Group 1. While some of this decline may be ascribed to the agricultural depression, other reasons must be sought to explain it, especially in some of the townships. Unfortunately, population data on Akeley Township prior to 1920 include Akeley Village, which was not incorporated until 1916, and hence only two census periods apply to this township. The average density of population for this group is 7.4. This general average is brought down by the inclusion of Hendrickson, Badoura, and Mantrap, with densities of 3.2, 6.3, and 6.3, respectively. The density ranges from 3.2 to 10.5, rather a wide range. This group is not so homogeneous, and hence no broad generalizations can be made. Apparently it has been able to resist the depression of the last decade less successfully than some of the other groups.

Group 5, composed of Rockwood, Fern, and Lake Emma townships, shows a remarkably uniform trend of population change, as is seen in Figure 6. All three of these townships appear to have practically

a stable or stationary population under present economic conditions, with all losing some ground during the last decade. The average density of the group is 6.3, with a range from 6.4 to 7.1.

The last pair of townships, Thorpe and Steamboat River, as seen in Figure 7, show the least similarity in percentage population change, even tho physically they are quite similar.

Their percentage population changes paralleled closely from 1910 to

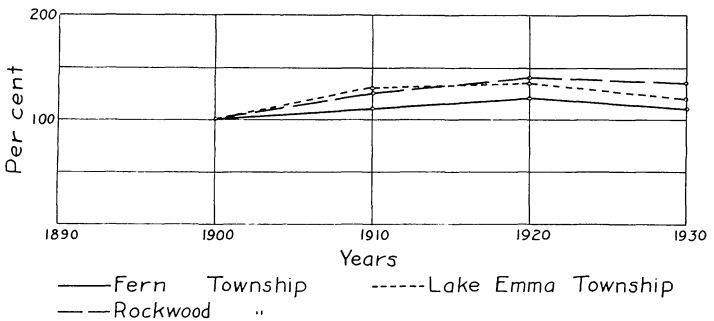

Fig. 6. The Percentage Change in Population of Townships in the Rockwood Group

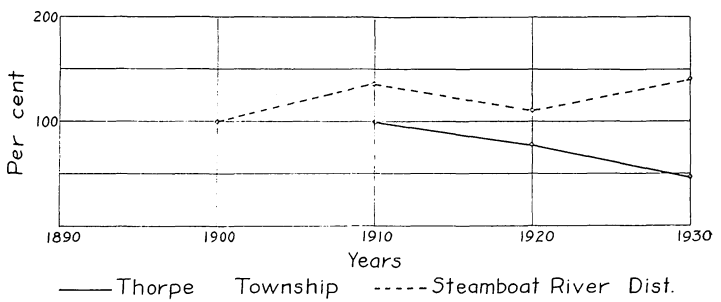

Fig. 7. The Percentage Change in Population of Townships in the Thorpe Group

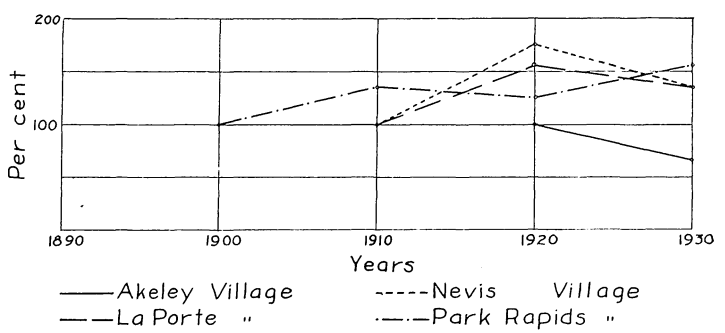

Fig. 8. The Percentage Change in Population of Villages in Hubbard County

1920, but since 1920 they have diverged sharply, Steamboat River District showing an increase practically equal in magnitude to the decrease in Thorpe. Because of the very small actual population in Steamboat River, the addition of a few individuals results in a larger percentage increase.

The population change in incorporated villages is shown in Figure 8. All of the villages show a definite decline in population, with the exception of Park Rapids, the county seat, which shows a definite increase. This difference suggests the tendency toward urban concentration.

A composite trend in the population was prepared for each group of townships referred to in the preceding discussion. These trends are shown in Figure 9.

The Thorpe and Steamboat River group of townships shows a definite decline since 1910. Their rapid increase prior to 1910 was due to the

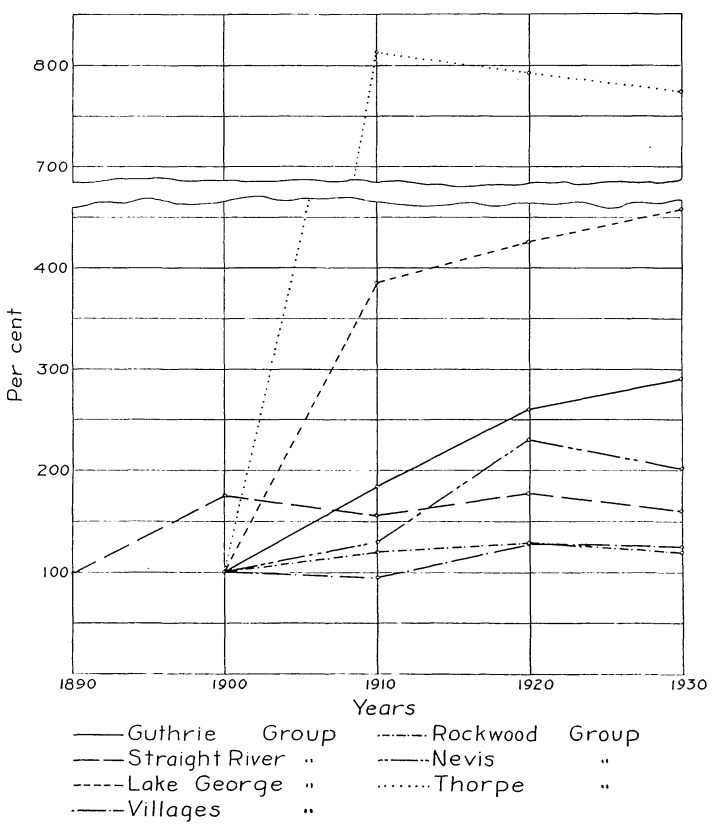

Fig. 9. The Percentage Change in Population of Township and Village Groups in Hubbard County

fact that their combined population was only 16 in 1900. The population in the Lake George group of townships likewise shows a rapid increase from 1900 to 1910 for the same reason and also because of the development of the timber industry in those townships during that period. The Guthrie district shows the most uniform trend, being but slightly deflected from practically a straight line trend by the agricultural depression in the last decade. Of all the groups of townships, the Nevis group shows the most pronounced decline in population during the last decade, the Straight River and Rockwood groups registering a slight decline.

URBAN DEVELOPMENT

Census data on villages in the county are incomplete, and hence it is difficult to make any close comparison of actual urban development. Five villages have been listed in census data since the county has been established, whereas at some time in the history of the county 12 villages have actually been started. Some of these had not been incorporated and hence are included in the data in the townships in which they are located. On the Great Northern Railway are Horton, on the south boundary of the county, Park Rapids, Dorset, Nevis, Akeley, Rosby, and Farris. Rosby is also located on the Soo Railway. On the Northern Pacific are Benedict, La Porte, Guthrie, and Nary. Hubbard is not located on a railroad. Of these, only four appear in the 1920 census, namely: Park Rapids, Nevis, Akeley, and La Porte, with populations of 2,075, 275, 514, and 185, respectively. The populations of all have declined, with the exception of Park Rapids which made a substantial gain.

Farris, which had a population of 135 in 1900, has disappeared entirely as far as urban population is concerned. A consolidated school, railroad station, potato warehouse, and a few abandoned residences remain.

Nary, on the Minnesota and International Railway, had been platted, but the platted area was vacated in recent years. It now maintains a flag station, a consolidated school, a store, and a church.

Rosby, on the Great Northern and Soo Line, has been at a standstill for some time. It has two stores, a co-operative creamery, which has recently been closed, and two potato warehouses.

Benedict, on the Minnesota and International Railway, has a post office and a general store.

Guthrie, on the Minnesota and International Railway, is not included in the census because it is included in the township of that name. It has a state bank, two cream stations, a garage, two general stores, a hardware store, a private electric light plant, a lumber yard, two churches, a lodge hall, a consolidated school, and a potato warehouse.

La Porte, on the Minnesota and International Railway, is incorporated. It has a bank, a barber shop, a blacksmith shop, a confectionery, a private creamery, a garage, a gas station, three general stores, a hardware store, a lumber yard, a restaurant, a full-time station agent, a real estate office, a private power plant, a shoemaker, two churches, a hotel, and a consolidated school.

Nevis, on the Great Northern Railway, is incorporated, has a barber shop, a blacksmith shop, two confectioners, two cream stations, a feed mill, a feed store, two garages, a gas station, two general stores, a hardware store, high-line electricity, a lumber yard, a meat market, a pool hall, two restaurants, a real estate office, a shoemaker, an undertaker, four churches, a hotel, a consolidated school, two potato warehouses, and a pickling plant.

Park Rapids, a county seat, is located on the Great Northern Railway and is served by a bus line from the Twin Cities to Bemidji. It is the only village to show a population increase since 1920. It is incorporated. In 1931 it had two banks, four barber shops, three blacksmith shops, a machine shop, a bottling works, two clothing stores, three confectioners, a co-operative creamery, four cream stations, two dentists, three doctors, two drug stores, two dry cleaners, two drygoods stores, a grain elevator, a feed mill, three feed stores, six garages, six gas stations, eight curb pumps, two general stores, four grocery stores, three hardware stores, a harness shop, high-line electricity, electric plant, a hospital, an ice-cream plant, two jewelers, a laundry, three lawyers, a library, two lumber yards, four meat markets, a photographer, two pool halls, four restaurants, a real estate office, a saw mill, two shoemakers, a movie theater, an auditorium, an armory, an undertaker, three variety stores, a veterinarian, two shoe stores, two plumbers, six churches, seven lodges, three hotels, two tire shops, a State Forest Ranger Station, water-works system, and eight blocks of concrete paving.

Akeley, incorporated in 1916, is located on the Great Northern Railway. It is the second largest village in the county. In 1931 it had a bank, a barber shop, two blacksmith shops, a confectionery, a private creamery, two cream stations, a dentist, a doctor, a drug store, an elevator, a feed mill, a feed store, two garages, two gas stations, two general stores, four grocery stores, a hardware store, a harness shop, high-line electricity, a lumber yard, two meat markets, two restaurants, a saw mill, two shoemakers, a stock yard, two potato warehouses, four churches, a hotel, and a water system.

Two newspapers are published in Park Rapids and one in Akeley.

The northern part of the county is in the Bemidji trade area. This may account for the lack of urban development in that part of the county.

IV. THE SOILS OF HUBBARD COUNTY[1]

ORIGIN OF SOIL MATERIAL OF HUBBARD COUNTY

About an eighth of the land surface of Hubbard County is covered by *peat soils* and the rest by *mineral soils,* commonly known as sands, loams, and clays. Mineral soils are familiar to everyone, being found in every country and every state, but peat is entirely absent in many countries, in many states in this country, and even in several counties in the southern part of Minnesota. Of all the states of the Union, Minnesota has the largest area of peat soil—about 7,000,000 acres. The proportion of its surface that is peat soil—about one eighth—is also larger than that of any other state. In Hubbard County, also, peat soils occupy an eighth of the surface.

These two great groups, mineral soils and peat soils, differ widely in their agricultural history and in the methods of management and fertilization necessary for their profitable use as well as in their origin, chemical composition, and physical properties. The mineral soils have been successfully cultivated since prehistoric times, while the problems of the management of peat soils have been solved only within the lifetime of men still actively engaged in farming. Mineral soils consist of rock or mineral fragments, except for a small amount of organic or vegetable matter accumulated in the surface layers from the roots, leaves, and fallen branches of plants that have grown upon the land. Peat soils are composed chiefly of organic matter—the remains of plants, most of which grew and died on the spot, and a smaller amount of mineral matter—partly that taken up from the soil and water by the plants while growing but chiefly that derived from the dust blown or the mud washed into the bog or lake as the peat was being formed. The peat layer varies from less than a foot in thickness to more than eight feet, while below it lies material of the same origin as that of the surrounding mineral soils.

During four different periods, many thousands of years ago, Hubbard County was covered by great ice sheets that spread from centers northwest of Lake Winnipeg.[2] In order of age, they are known as the Nebraskan—the oldest, the Kansan, the Iowan, and the Late Wisconsin. Between the successive ice invasions, which were accompanied by extreme cold, were long intervals with a milder climate, much like the

[1] This chapter was prepared by F. J. Alway, chief of the division of soils, and P. R. McMiller, assistant professor of soils, University of Minnesota.

[2] A full account of the glacial history of Minnesota is given in a monograph by Frank Leverett—Quaternary geology of Minnesota and parts of adjacent states. U. S. Geol. Survey Professional Paper 161. (1932)

present, during which the ice melted back to its center of dispersion and the land became covered with vegetation. In each advance the ice brought enormous quantities of rock fragments, partly as stones varying in size from pebbles to huge boulders, but mostly as finer material, sand, silt, and clay. When the ice melted it dropped the transported material, known as glacial drift, including many large and small fragments of limestone brought from Manitoba. In most places the slowly moving ice picked up and carried away the surface soil and part of the subsoil, leaving these in the glacial drift commingled with material brought from a greater distance and that collected nearer the place of deposit. Consequently, little evidence remains of the surface soil that was formed during the interglacial intervals. Where the front of the ice sheet melted back much more rapidly than it advanced, the glacial drift was left in the form of *till plains,* also known as ground moraines, which in Hubbard County are represented by the large, comparatively smooth area of heavy soils that lie north of the central ridge. Where it advanced about as rapidly as it melted or where it hesitated, first retreating a short distance, then readvancing, the deposit of glacial drift became deeper and rougher and on its final retreat the ice left what is known as a *terminal moraine,* well illustrated in Hubbard County by the central ridge. The water rushing from the melting ice front carried great quantities of fine material, known as rock flour, and rolled along gravel, pebbles, and cobbles. Where the velocity of the water slackened, these stones were deposited along with sand to form *outwash plains,* such as occupy most of the county south of the central ridge. The finer particles, silt and clay, transported by the water were chiefly carried beyond the confines of the county but in a few cases were deposited in ponds or small lakes, where we now find the heavy soil called Beltrami silt loam.

The last ice sheet, the Late Wisconsin, is responsible for at least the uppermost portions of the glacial drift of the terminal moraine forming the central ridge, of the till plains to the north of this, and the outwash of the sandy and gravelly plains to the south. Part of the plain near Chamberlain, in the southeastern part of the county, was probably formed by outwash from a terminal moraine of a somewhat earlier ice sheet, known as the Middle Wisconsin, whose western front came close to the eastern side of Hubbard County. Unlike the ice sheets mentioned above, this one spread from a center to the east of Hudson Bay, advancing into Minnesota from the northeast, and leaving a drift with but few limestone fragments.

DEVELOPMENT OF THE SOILS

As the last ice sheet withdrew, the surface of both drift and outwash was occupied by vegetation, and then began the slow change from mere soil material to what is recognized as actual soil. The surface layers of the mineral soils are now different from the upper subsoil, and this in turn has properties that distinguish it from the lower subsoil. But when the ice first withdrew from Hubbard County, the drift was alike at the surface and below to whatever depth the deposit by the last ice sheet extended, resembling what we may now see in deep road cuts at a depth of more than six or seven feet below the surface, gray in color and rich in carbonates, commonly known as lime.

The character and extent of the changes—known as weathering—that gradually took place are due partly to the climate and partly to the vegetation growing on the surface. Alternate wetting and drying, freezing and thawing, caused the larger particles to break down into smaller ones; the action of oxygen and carbonic acid caused chemical changes in part of the material, and water sinking downward from the surface gradually dissolved the carbonates from the upper portions and carried them down to the water table, from which they passed into the streams and lakes. Rains and melting snows carried downward many of the very fine particles formed at the surface by weathering and deposited them in what is now the upper subsoil, making this finer in texture and more impervious to water, while at the same time the surface became coarser and more open. Wherever the climate was favorable for forest growth, the trees covered the surface of the ground with what is known as forest floor, which consists of the more or less decomposed remains of the leaves and fallen branches of the trees as well as of the smaller plants growing in their shade. In the upper part of the forest floor, the *litter,* the leaves are easily recognizable, while in the lowest portion, the *leafmold,* they are not. Below the leafmold is found a dark layer of soil from half an inch to two inches in thickness, and below this is a lighter-colored layer, in some places almost white, from 4 to 12 inches in thickness, which in turn is underlain by the finer-textured layer resulting from the transfer of fine particles from above. Finally comes the unchanged or but slightly altered glacial drift or outwash, which is referred to as the *parent material* of the soil.

Where conditions were unfavorable for the growth of trees but favorable for grasses, no forest floor was formed. Instead, the dead roots of the short-lived plants, together with such of their leaves and stems as were carried below the surface by insects, have given rise to the brown or black material that gives our prairie soils their well-known dark color. The rather deep dark surface layer of grasslands is formed

very slowly, but it remains a long time, even after a forest has taken possession of the land.

HOW THE SOIL MAP WAS MADE[3]

On the colored soil map which accompanies this report 24 soil types, or different soils, are shown. In a soil survey the soil type is the unit of classification, and soil types are differentiated on the basis of the character of the entire profile and not of the surface only. In determining the agricultural value of a soil the character of the subsoil may be quite as important as that of the surface layer, the part dealt with in plowing and cultivating. A soil with a rather poor surface but with a good subsoil may be much more valuable for farming than one with an excellent surface but poor subsoil. So in order to decide upon the boundary between two adjacent soil types, it is necessary to know the nature of the subsoil to a depth of at least three or four feet. In order to secure this necessary information regarding the subsoil, the soil surveyors use long augers and at intervals also the spade to get a still better idea of the profile. Fresh road cuts are carefully examined and old cuts are trimmed with the spade so as to expose a fresh surface.

The soil surveyors walked along all the roads and also along all the trails that are shown on the soil map, examining the soil at frequent intervals with a three-foot auger. In the case of any section that had no roads or trails along two sides of it, or through it, the soil was examined along a section or quarter-section line, following this through the woods with the aid of a compass. All such lines of examination, called *traverses,* are shown on the map as broken heavy lines to distinguish them from the roads. At intervals, in order to locate the boundaries of soil types, or the position of streams, lakes, or other features, the surveyors made offsets, or side trips, from these straight-line traverses. As most of these offsets, as well as the roads and the trails along which the examination was made, are shown on the map, anyone using the map can see just where the surveyors have gone. Often a thick forest growth prevented them from seeing more than a few rods on either side. In drawing the soil-type boundaries it was assumed that the soil back from the roads and traverses is like that along the nearest of these, but wherever clearings, open swamps, lakes, and hills along the roads and traverses permitted a wider view the surveyors took advantage of them.

[3] The soil survey of Hubbard County was made by P. R. McMiller of the University of Minnesota, assisted by C. S. Simmons, G. A. Swenson, and W. J. Leighty of the Bureau of Chemistry and Soils of the United States Department of Agriculture.

HOW A LANDSEEKER MAY BEST USE THE SOIL MAP

Land for farming should not be bought on the strength of this map alone. After examining the soil map and reading the descriptions of the soil types in the following pages, a prospective purchaser should go over the whole tract in which he is interested.

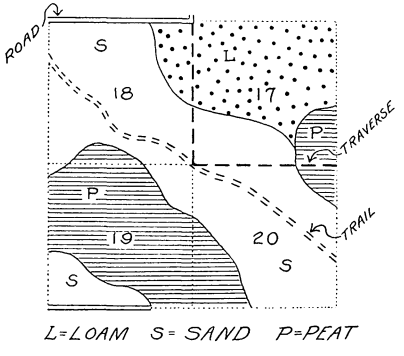

Fig. 10. Four Sections Showing Soil Types, Roads, and Traverses

As an example of how to use the map we may assume that one wishes to buy an 80-acre tract, avoiding both peat and light sand, and has been offered his choice of any of the land on four adjacent sections, 17, 18, 19, and 20, shown in Figure 10. Three very different soil types are shown: (1) *peat* (P), which is not adapted to ordinary methods of farming; (2) a *light sand* (S), covered with jackpines and known to be very drouthy; (3) a *loam* (L) with a clay loam subsoil, rolling enough to provide good natural drainage and covered with large hardwoods. The usual landseeker will wish to buy only land with the last kind of soil. From the map it may be seen that the only roads touching any of these sections are a trail which winds from southeast to northwest across sections 20 and 18, a road on the south side of the SW¼ of section 19 leading up to the swamp, and a road along the north side of section 18. Traverses from a point on the trail were made along the west and south sides of section 17. So it may be seen that the soil was examined by the soil surveyors along only the two roads, the trail and the traverses.

From the map he would probably at once decide that he is not interested in sections 19 and 20 or in the south half of 17 or the south half or northwest quarter of 18, because of the sand and peat. That would leave only three out of the original 16 quarter sections for him to examine, viz., the north half of 17 and the northeast quarter of 18. On personally inspecting these, he might find that the loam type occupied almost the whole of the northeast quarter of 18, hardwoods on portions of this having been hidden from the surveyors by the intervening pines. On the north half of 17 he might find a considerable area of peat or of sand, the shorter natural growth on these types having been hidden from the line of traverse by the intervening taller hardwoods.

If the land back from the roads and traverses is very different from what is indicated on the map, the owner will usually know about this and if he thinks any of it is better than is indicated on the map one may expect him to call attention to it.

NAMING THE SOIL TYPES

The soil survey of Hubbard County was carried out in co-operation with the Bureau of Chemistry and Soils of the United States Department of Agriculture, and to the latter organization is left the naming of every soil type as well as the decision as to what differences in character are sufficient to justify the recognition of a new soil type. This bureau has co-operated in the soil survey and mapping of more than 500,000,000 acres in this country, including more or less of every state in the union. In the course of this work it has recognized and named more than 5,000 different soil types. The name of each soil type, Hubbard sandy loam, for example, consists of two parts. The one, called the *soil class* name, indicates the texture of the surface soil, sandy loam in this case, while the other, known as the *soil series* name, is some geographic name from the vicinity of the place where the soil type was first mapped and refers to the profile characteristics and the topography. When in the course of the survey of a county there is found a soil with a profile distinctly different from any previously mapped in this country it is given some local geographic name as its series name. Care is necessary in the selection of the name to avoid the use of one previously assigned, as nearly 1,400 soil series have so far been recognized in the United States.

It will be observed that of the 22 mineral soil types of Hubbard County, listed in Table 9, all but two, beach sand and mixed stream deposits, bear geographic names, followed by the term descriptive of the texture of the soil. Four of the names are from Hubbard County, namely, Hubbard, Dorset, Todd, and Arago, four from Wadena County, five from Beltrami County, and one from Itasca County. Hubbard and Todd are townships, Dorset a village, and Arago a post office. The use of some Wadena, Beltrami, and Itasca county names is due to soil surveys of the first and of parts of the other two counties having been made before beginning work in Hubbard County. The giving of northern Minnesota names to 14 soil series mapped in it indicates that practically all the mineral soils in Hubbard County are considered different from those previously surveyed in other states or in the southern and western counties of this state.

Table 9
Soil Types of Hubbard County

	Square miles	Acres	Per cent
Rockwood sandy loam	200.7	128,448	21.5
Peat (deep)	114.8	73,472	12.3
Rockwood stony sandy loam	108.1	69,184	11.6
Menahga loamy sand	82.6	52,864	8.8
Todd sandy loam	80.5	51,520	8.6
Rockwood loamy sand	53.8	34,432	5.8
Rockwood loam	46.6	29,824	5.0
Marquette sandy loam	39.0	24,960	4.2
Hubbard sandy loam	36.3	23,232	3.9
Arago loamy sand	33.0	21,120	3.5
Dorset sandy loam	26.6	17,024	2.8
Nebish loam	23.1	14,784	2.5
Marquette loamy sand	16.5	10,560	1.8
Kinghurst loamy sand	12.7	8,128	1.4
Nymore loamy sand	11.8	7,552	1.3
Bluffton loam	10.8	6,912	1.1
Nymore sandy loam	8.2	5,248	0.9
Sebeka loamy sand	7.9	5,056	0.8
Hubbard loamy sand	5.5	3,520	0.6
Beltrami silt loam	4.5	2,880	0.5
Cass Lake fine sand	4.2	2,688	0.4
Mixed stream deposits	3.9	2,496	0.4
Beach sand	0.5	320	0.1
Peat (shallow)	0.3	192	0.1
Muck	0.1	64	0.1
	932.0	596,480	100.0

Table 10
Soil Groups of Hubbard County

	Per cent of county
1. Medium to heavy loam soils	29.5
Rockwood sandy loam	
Rockwood loam	
Nebish loam	
Beltrami silt loam	
2. Sandy loam soils with sandy or gravelly subsoils	20.1
Hubbard sandy loam	
Hubbard loamy sand	
Dorset sandy loam	
Todd sandy loam	
Marquette sandy loam	
3. Light sandy soils	18.1
Nymore loamy sand	
Nymore sandy loam	
Menahga loamy sand	
Kinghurst loamy sand	
Cass Lake fine sand	
Arago loamy sand	
Marquette loamy sand	
4. Sandy soil with heavy subsoil	5.8
Rockwood loamy sand	
5. Rough stony loam	11.6
Rockwood stony sandy loam	
6. Poorly-drained mineral soils	2.4
Bluffton loam	
Sebeka loamy sand	
Mixed stream deposits	
Beach sand	
7. Peat soils	12.5
Peat-deep	
Peat-shallow	
Muck	

DESCRIPTION OF THE SOIL TYPES

Twenty-four soil types have been mapped in Hubbard County, the most extensive occupying one-fifth of the land surface while the least extensive covers only 64 acres. In Table 9 they are arranged in order of extent, showing the area of each in square miles as well as in acres and the percentage of the land area of the county which it occupies. In order better to bring out the differences among these soil types and to consider their agricultural value, they will be dealt with in seven groups, two of these being represented by a single soil type each (Table 10).

Medium and Heavy Loam Soils

The four heavy soil types suitable for farming occupy nearly a third of the county and are found chiefly north of the central ridge (Fig. 11).

Soil type	Acres	Per cent of county	Per cent in crop land
Rockwood sandy loam	128,448	21.5	11
Rockwood loam	29,824	5.0	14
Nebish loam	14,784	2.5	14
Beltrami silt loam	2,880	0.5	22
Group	175,936	29.5	12

The first three types, developed on the glacial drift, carry varying amounts of stone—both at the surface and below, boulders, cobbles and pebbles, while the Beltrami silt loam is practically stone-free, having developed on clayey material deposited in ponds and small lakes during the retreat of the ice sheet.

On all four types the subsoil, varying from heavy to moderately heavy, is retentive of moisture and the surface layer is too fine in texture to be subject to drifting. They are much the most drouth-resistant agricultural soils in the county, with the exception of the poorly-drained mineral soils and the peat. The surface in general is rolling enough to provide good drainage without being so rough as to exclude the use of modern farm machinery.

All the soils of this group are productive soils. While their natural supply of nitrogen is low, compared with that of the black soils of the prairie portions of the state, this is not a serious disadvantage, because dairying, the system of farming almost universally practiced on them and the one best adapted to them, involves the growing of clovers or alfalfa on a large part of every farm and the feeding of nearly all the crops grown, followed by the use of the resulting manure. The clovers and alfalfa collect nitrogen from the air and store it as protein in their tops and roots. The nitrogen of this protein removed to the barns in the hay is largely returned to the fields in the manure. When these

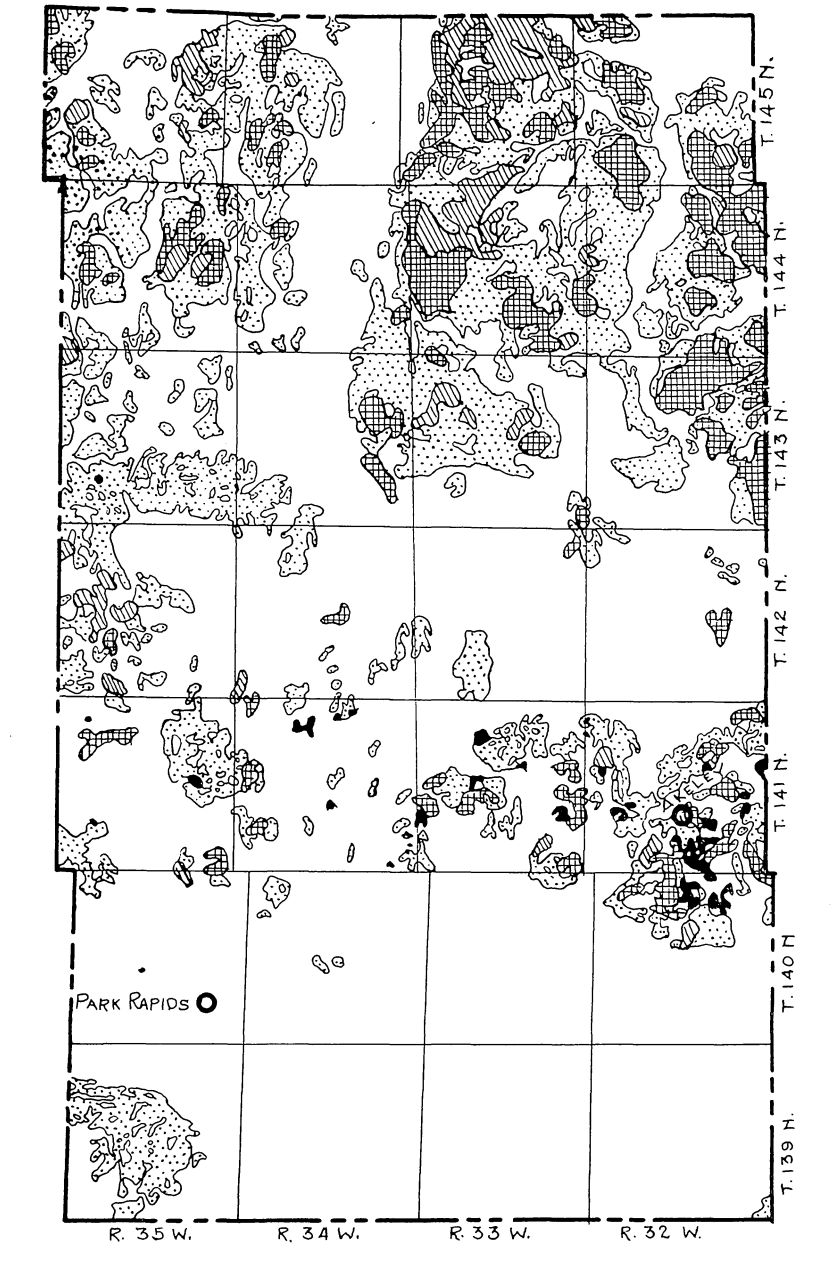

Fig. 11. Distribution of Medium and Heavy Loam Soils

legume crops form a sufficiently large part of the crop acreage, and the manure is properly handled, they provide the nitrogen required by the non-leguminous crops—small grains, corn, potatoes, and grasses, which follow in the rotation.

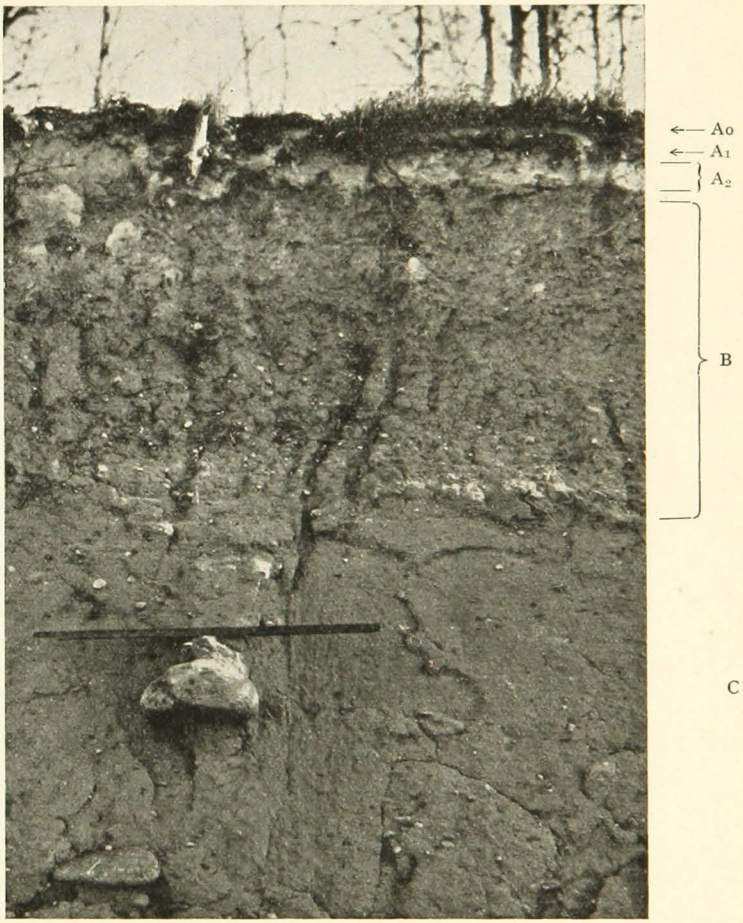

Fig. 12. Profile of Nebish Loam Showing Different Horizons or Soil Layers

The supply of lime in these soils is adequate for the successful growth of alfalfa and sweet clover. Their low nitrogen content, which is common to forest soils, is far less serious than would be a lack of sufficient lime for these legume crops. The supply of potash and phosphate is at least fair, up to the present but little or no response having been found to either potash or phosphate fertilizers. Sulfur is present

in sufficient amounts for farm crops other than clovers and alfalfa, which on many fields respond to applications of sulfur fertilizers (see p. 107).

Stoniness is a characteristic of the first three soils of this group—Rockwood sandy loam, Rockwood loam, and Nebish loam. The amount of stone at the surface varies greatly within short distances, in some places the boulders being so large and numerous as to make the cost of removing them prohibitive, while here and there are found small patches almost free of stones large enough to interfere seriously with cultivation, these extremes often being found on the same farm. The stones below the surface, which also vary widely in amount within short distances, are not a serious disadvantage when they are well beyond the reach of the plow, as boulders and cobblestones in loam, clay loam, or clay subsoils appear not to reduce the moisture supply to crops.

Table 11

Typical Profiles of Heavy and Medium Loam Soils in Virgin Condition

Horizon*	Depth, inches	Rockwood sandy loam	Depth, inches	Rockwood loam	Depth, inches	Nebish loam	Depth, inches	Beltrami silt loam
A_0		Forest floor		Forest floor		Forest floor		Forest floor
A_1	0-1	Black sandy loam	0-1	Black loam	0-1	Black loam	0-1	Black silt loam
A_2	1-13	Gray sandy loam with some stone	1-11	Gray loam with some stone	1-12	Light gray loam with some stone	1-8	Very light gray loam, free of stone
B	13-39	Brownish-gray sandy clay with many sand pockets and some stone	11-33	Brownish-gray sandy clay with a few sand pockets and some stone	12-32	Dark yellowish-brown silty clay, very tough, with some stone	8-27	Brownish-yellow, very tough silty clay, free of stone
C	39+	Reddish-brown or brownish-gray sandy loam with some stone	33+	Brownish-gray clay loam with some stone	32+	Brownish-yellow silty clay with some stone	27+	Grayish-yellow silt or very fine sand, free of stone

* A *soil profile* is a vertical section of the soil from the surface into the underlying unweathered material. If it is definitely representative of a soil type it is known as a *typical profile*.

A *soil horizon* is a layer or portion of the soil profile, more or less well defined and occupying a position approximately parallel to the soil surface. In Hubbard County soils three horizons are recognized, A, B, and C, which are also referred to as the surface soil, upper subsoil, and lower subsoil (see Fig. 12).

Horizon A is the upper portion of the soil mass, from which material has been removed and carried downward by rain and snow waters. In virgin forest soils three subhorizons are recognized—A_0, A_1, and A_2. A_0 consists of the forest floor, A_1 is the uppermost dark-colored layer of mineral soil, and A_2 the light-colored, leached layer almost free of organic matter. When the land is plowed A_0 and A_1 become mixed with the upper part of A_2, or, where the last is very shallow, even with the whole of A_2 and the uppermost part of the B horizon to form the plow zone or seedbed.

Horizon B, or upper subsoil, is the layer that has developed as a result of the accumulation of material from the A horizon through the downward movement of water.

Horizon C, or lower subsoil, underlies the B horizon. It consists of unweathered material but usually shows some modification in the upper portions. In most cases it represents the "parent material," being similar to that from which the overlying horizons were formed but in some cases it is a geological formation of very different material.

The preparation of these heavy soils for the plow has consumed much time and labor, owing to the presence of surface boulders and large pine stumps, and this handicap chiefly accounts for the small proportion so far brought under cultivation.

Table 11 shows the outstanding similarities and differences of the four soil types as they appear when examined in fresh road cuts or in pits dug in virgin soil. At the surface there is a two- to three-inch surface layer of forest floor, consisting of freshly fallen and partly disintegrated leaves over black leafmold, below which is an inch or so of dark soil. Below the latter is a light gray layer, 7 to 12 inches in thickness, known as the *leached layer,* which is mellow, readily breaking down between the fingers when dry, and in appearance resembles hardwood ashes (Fig. 12). Next is a compact, somewhat cemented layer, varying from 16 to 30 inches in thickness, much darker in color—yellowish brown, brownish gray, or coffee brown, which with increasing depth changes gradually into lighter-colored, uncemented material that is about equally fine in texture and continues downward with little change, except in the case of the Beltrami silt loam.

When first plowed, the fields have a mottled appearance due to the light color of the leached layer in the overturned furrow slice being interrupted by strips of the dark surface layer, but after the land has been under cultivation a few years the dark organic matter of the surface layer becomes thoroly mixed with the upper part of the leached layer, with the result that the surface soil of the plowed fields assumes a uniform, rather light gray color.

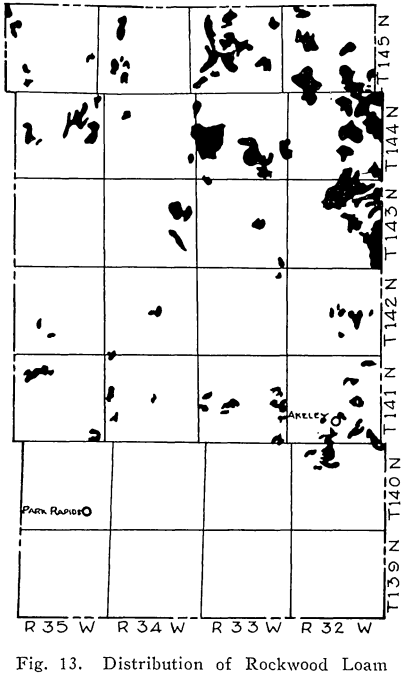

Fig. 13. Distribution of Rockwood Loam

Rockwood sandy loam, which covers nearly three times as large an area as the other three types together, lies mostly north of the central ridge but there are considerable tracts just to the south of this, with an isolated area of about 7,000 acres in the southwestern corner of the county. It has good surface drainage, the relief in general ranging from gently rolling to rolling, but on scattered areas being sharply rolling. Carbonates, commonly called lime, are in most places encountered first at five feet or more below the surface.

Rockwood loam, found chiefly in the northeastern townships (Fig. 13) is only about a fourth as extensive as the Rock-

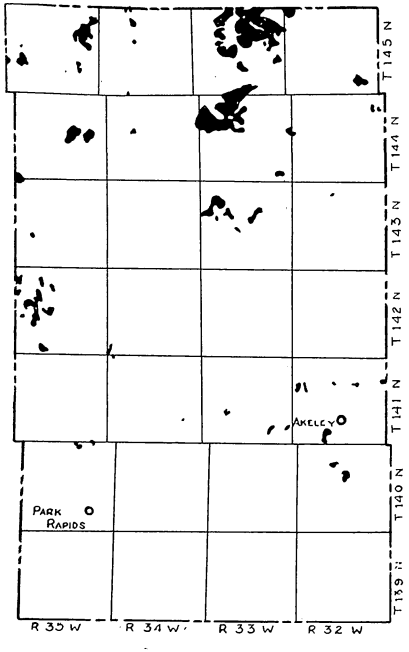

Fig. 14. Distribution of Nebish Loam

wood sandy loam, with which it is associated and from which it differs in having a somewhat finer-textured surface, fewer pockets of sand in the subsoil, a less rolling surface and consequently less complete surface drainage. Its heavier surface causes it to be more retentive of moisture and somewhat more drouth-resistant than the Rockwood sandy loam but this advantage is partly offset by its drying off more slowly after the spring thaw and after rains and so causing longer delays in field work. In stoniness the two types are similar.

Nebish loam is only half as extensive as the Rockwood loam, being practically confined to Helga and Guthrie townships, where it occurs adjacent to Rockwood loam and Rockwood sandy loam (Fig. 14). The surface soil of the Nebish loam is in general about as heavy as that of the Rockwood loam, or a little heavier, while the subsoil is distinctly heavier and more compact. Its relief varies from undulating to gently rolling (Fig. 15), and like the Rockwood loam it endures drouth somewhat better than the Rockwood sandy loam, and dries off more slowly after rains and after the spring thaw. Tracts with comparatively few surface stones are more common on this soil type than on either of the two Rockwood soils described above, but in general Nebish loam carries many boulders, both at the surface and below. It so closely resembles Rockwood loam that in mapping it was difficult in many places to decide upon a line of separation, the one soil type passing so gradually into the other that many patches of Nebish loam may be found within areas mapped as Rockwood loam and patches of Rockwood loam may occur where the soil map shows only Nebish loam. The chief distinction between the two is in the subsoil, which in the Nebish loam is free of sand pockets as well as somewhat finer in texture and more compact. Carbonates occur nearer the surface in the Nebish, usually being found in the upper half of the third foot, while in the Rockwood loam they are first encountered in the fourth or fifth

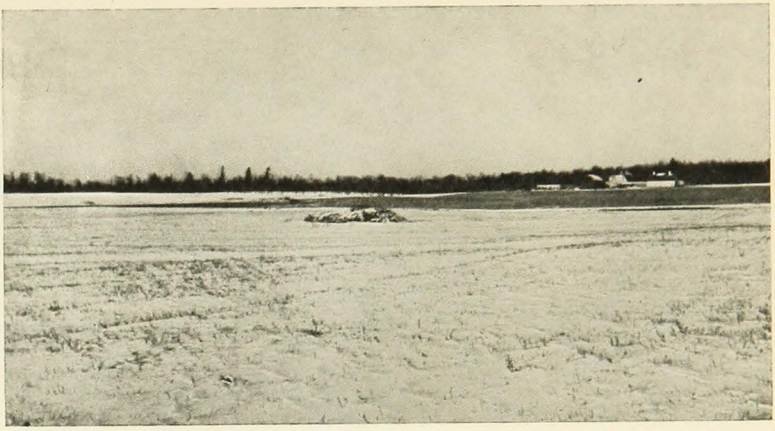

Fig. 15. A Farm on Nebish Loam With an Exceptionally Large Acreage of Plow Land, Showing the Gently Undulating Relief
In the middle foreground is a pile of boulders gathered from the fields.

foot, and in the Rockwood sandy loam in the sixth foot. There is no evidence, however, that the nearer approach of carbonates to the surface on the Nebish loam makes it more productive of alfalfa and clover than the Rockwood loam or Rockwood sandy loam, both of which appear to carry enough lime. The three types may be considered as nearly equal in value as farm land.

Beltrami silt loam occurs along the south side of the central ridge, occupying only 2,880 acres, divided among some thirty small tracts, the largest lying south of the Village of Akeley (Fig. 16). Few fields are entirely on this soil type. Most of the cultivated parts of it are included in fields which are mainly on Rockwood loam or Rockwood sandy loam. It has a heavy surface and heavy subsoil, is practically free of stones, both at the surface and below, and good drainage is provided by its relief, usually sharply rolling but in a few places only gently rolling.

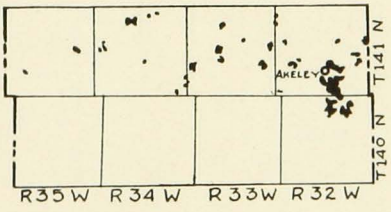

Fig. 16. Distribution of Beltrami Silt Loam

Its freedom from stone and its good surface drainage make this soil type attractive as farm land, but the very heavy character of its surface makes it hard to work, and the slowness with which it dries off shortens the periods when tillage operations can be carried out, thus making more difficult the eradication of noxious weeds, especially quack grass. As a result, the improved portions of Beltrami silt loam are now used largely as permanent meadows and pastures.

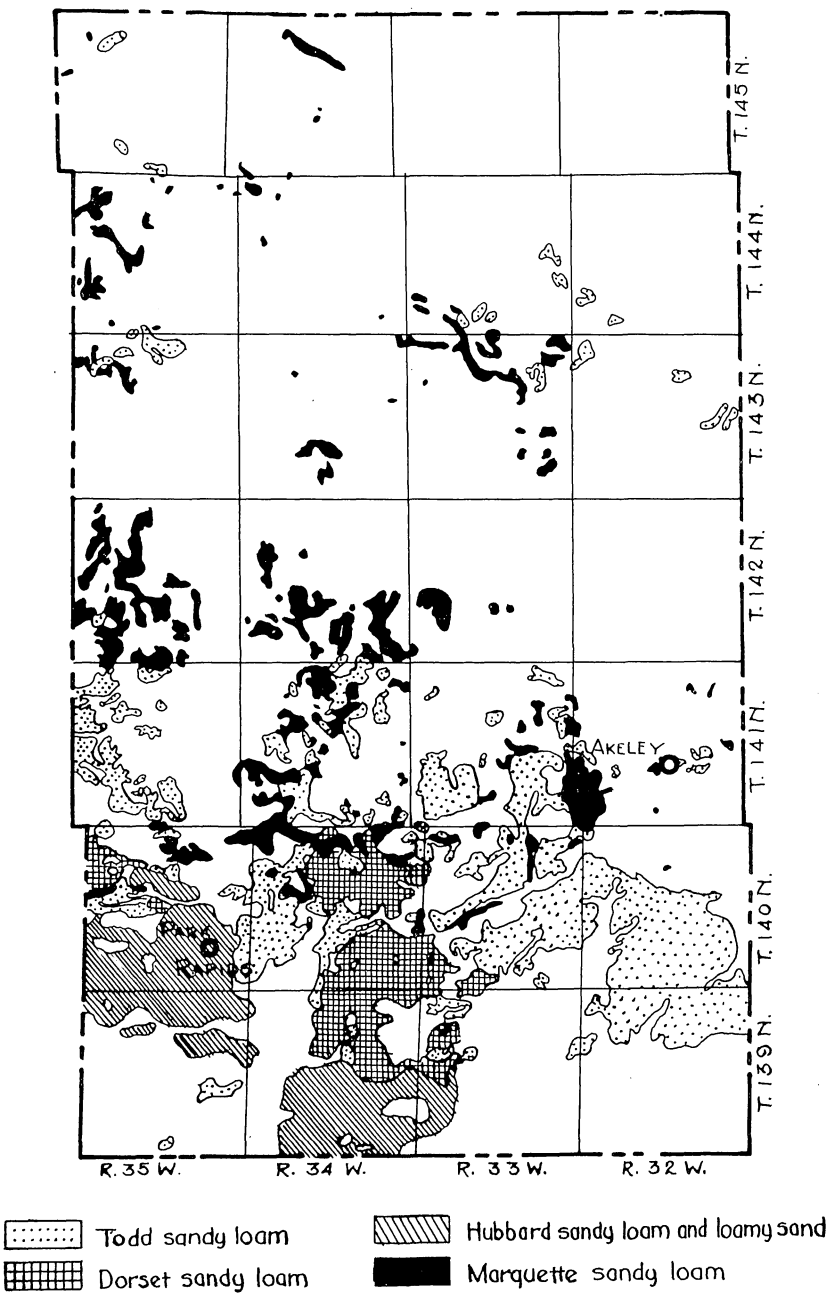

Fig. 17. Distribution of Sandy Loam Soils with Sandy or Gravelly Subsoils

Sandy Loam Soils with Sandy or Gravelly Subsoils

The group of sandy loams with gravelly or sandy subsoils is next in extent to the heavy soils dealt with above, covering a fifth of the county. They are found almost entirely south of the central ridge (Fig. 17). While they occupy only about two-thirds as large an acreage as the heavy soils, they provide about two and a half times the acreage of crop land and up to the present have been much the more important agriculturally. When settlement of the county began, about 1880, a part of their area consisted of so-called "prairie openings" with scattered patches of jack pine, while the remainder was covered with jack pine, with some Norway pine and more or less bur oak, aspen, and birch. Five soil types are included in this group.

Soil type	Acres	Per cent of county	Per cent in crop land
Hubbard sandy loam	23,232	3.9	81
Hubbard loamy sand	3,520	0.6	50
Dorset sandy loam	17,024	2.8	68
Todd sandy loam	51,520	8.6	32
Marquette sandy loam	24,960	4.2	9
Group	120,256	20.1	42

The first four types, developed on glacial outwash of sand and gravel, carry little or no stone to interfere with cultivation and have good surface drainage. They have a good surface soil, which carries enough fine material to make an excellent seedbed and prevent serious drifting and has sand enough to make cultivation easy. Their great weakness lies in their drouthy subsoils. In years of liberal and well-

Table 12

Typical Profiles of Sandy Loam Soils in Virgin Condition

	Dark-colored soils				Light-colored soils			
Horizon	Depth, inches	Hubbard sandy loam	Depth, inches	Dorset sandy loam	Depth, inches	Todd sandy loam	Depth, inches	Marquette sandy loam
A_0		Forest floor		Forest floor		Forest floor		Forest floor
A_1		*		*	0-1	Brown sandy loam	0-1	Brown sandy loam
A_2	0-10	Dark grayish-brown sandy loam	0-12	Dark grayish-brown sandy loam	1-13	Brownish-gray loose loamy sand	1-11	Yellowish-gray loose sandy loam with much stone
B	10-23	Grayish-brown sandy loam or sandy clay loam with a few pebbles and small cobbles	12-29	Grayish-brown sandy loam with many pebbles and some cobbles	13-26	Reddish-brown sandy loam with pebbles and small cobbles	11-28	Reddish-brown gravelly sandy loam with many pebbles, cobbles, and boulders
C	23+	Yellowish-brown gravel or sand and gravel mixed	29+	Yellowish-brown sand and gravel with many cobbles	26+	Gray sand and gravel with pebbles and some small cobbles	28+	Loose coarse sand and gravel with many pebbles, cobbles, and boulders

* Horizons A_1 and A_2 not distinctly separated.

distributed rainfall they give satisfactory yields. The surface soil is retentive of moisture, while the coarse subsoil prevents any excess. In the spring the soil warms up rapidly and can be worked and sown early to spring grains with little risk of soil drifting. Typical profiles are described in Table 12.

In 1879 when settlement of the southern townships began, there were two open areas which were named, in the order in which they were approached from the railway and settled, First Shell Prairie or Hubbard Prairie, and Second Shell Prairie or Park Rapids Prairie. The former covered most of Hubbard Township and part of Henrietta, while the latter occupied much of Todd Township and the northern edge of Straight River. When the land survey of the county was begun these areas were covered by forest, altho they have dark-colored, prairie-like soils, evidence that for considerable periods they must have been open grassland.

The township lines of the southern eight townships were surveyed in October and November, 1860, by J. W. Meyers with six helpers, and during the following two months Hubbard, Henrietta, and Straight River townships were subdivided into sections by Mahlon Black with seven helpers, including five of those who had helped Meyers. The surveyors recorded the character of the vegetation along the four sides of every section, as, for example, in the case of the first two sections in Hubbard Township to be settled upon.

	Section 26	Section 28
South side	Jack pine, Norway pine, hazel, oak, and aspen	Jack pine and oak
East side	Jack pine, Norway pine, and aspen	Jack pine, Norway pine, hazel, and aspen
North side	Jack pine and Norway pine	Jack pine and oak
West side	Jack pine, Norway pine, and scattering aspen	Oak and pitch pine

No mention of prairie, openings, or burns appears in the land surveyors' detailed notes or in their general description of the three townships.

Todd Township was not subdivided until August, 1871, when it was surveyed by Allen and Putnam with six helpers, none of whom had helped Meyers or Black eleven years before. In the case of 14 sections in the southern and southeastern part of the township, prairie was recorded and in the general description of the township it is stated that "the prairie in the southern portion of the township is level."

From the above it is evident that at the end of 1860 there was no prairie in Hubbard, Henrietta, or Straight River townships, but eleven years later there was an extensive tract near the junction of Henrietta

and Straight River townships, while there is no doubt that by the time settlement began in 1879 there were extensive prairie openings in Hubbard and Henrietta townships as well as in Todd. Such a change may be accounted for by assuming that shortly after the survey was made in 1860-61 forest fires overran much of Hubbard and part of the adjacent townships.

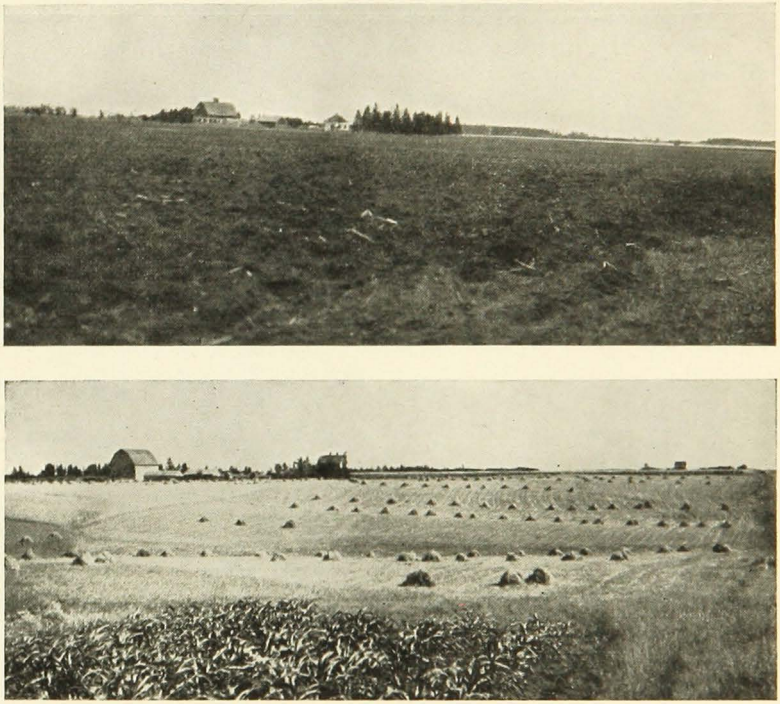

Fig. 18. The Inviting Sandy Loams
Hubbard sandy loam, above; Dorset sandy loam, below.

The ease with which these four types could be brought under the plow, their freedom from stone, their level to gently rolling topography, and the readiness with which passable roads could be established, owing to the relative absence of bogs and sloughs, all combined to invite early settlement. The most attractive of the group and the most productive of small grains were the dark-colored soils, the Hubbard and Dorset sandy loams, on which were the First and Second Shell Prairies (Fig. 18). They had a great advantage for grain farming, being the richest in nitrogen, the plant nutrient with which forest soils in general are by nature most poorly supplied, but this advantage is now largely a thing of the past and is likely to become still less important because success

in dairy farming, the system now prevailing in the county, requires that a large part of the farm be devoted to the growing of legumes.

These sandy loams have a fairly good natural supply of mineral nutrients, but they are likely to prove inferior to the heavier soils in potash. On some of the fields longest devoted to farming without the use of manure an application of potash has been found to increase the yields markedly. No evidence of sulfur deficiency has so far been found on the Hubbard and Dorset soils, but on the Todd sandy loam the response of legumes to sulfur fertilizer appears to be about the same as on the heavy soils and the light sands (see p. 107).

The lime supply in these soils is sufficient for the common clovers and in most places even for alfalfa and sweet clover, but on some fields liming appears indispensable for these last two crops. In various places over the southern part of the county, where these soils are found, there are extensive beds of marl of excellent quality, which will provide a cheap local source of lime for agricultural purposes.

Hubbard sandy loam. The relief of Hubbard sandy loam ranges from nearly level to undulating. The surface is free of stones and in the subsoil but few large cobbles are found. The surface soil is a dark grayish-brown sandy loam, about eight inches in depth, which appears almost black when wet. Under this is a 10- to 14-inch layer of brown sandy loam, containing a considerable number of pebbles and small cobbles. When wet it is somewhat reddish and more sticky than the surface layer; when dry it is so hard and difficult to penetrate with the spade that it is locally referred to as "hardpan," but it is not true hardpan and offers no obstacle to the penetration of plant roots, which develop only in moist soil. Below this is a deep bed of gravel and coarse sand, generally beginning at 18 to 24 inches below the surface, commonly in alternating layers of widely varying thickness and often carrying many pebbles and small cobbles. The weakness of the Hubbard sandy loam, like that of the other soils of this group, is not due to any defect in the first two layers, but to the last, whose low water-retaining capacity compared with that of the overlying layers may be seen in Figure 33.

Hubbard loamy sand was mapped on less than 16 square miles, chiefly in the form of small tracts surrounded by or adjacent to Hubbard sandy loam, seldom forming the whole of any field. Much the largest area mapped centers in section 25 of Hubbard Township, covering about 1,000 acres. The typical Hubbard loamy sand differs from the Hubbard sandy loam by having a somewhat shallower and lighter-colored surface layer and a thinner and coarser second layer. Accordingly, the typical Hubbard loamy sand is more drouthy and less pro-

ductive than the typical Hubbard sandy loam. However, so much that was mapped as Hubbard loamy sand is so similar to the sandy loam in general character that, in appraising their agricultural value, the two may be considered alike, except in the case of the largest areas of the former. They are similar in natural vegetation, gentle relief, and freedom from stone.

Dorset sandy loam is confined to the southwestern part of the county, where it forms an almost solid body lying east and northeast of Long Lake, except for a small isolated area which was mapped near the northwestern corner of Todd Township. On the south it is bordered by the eastern area of Hubbard soils, and, like these, it was partly open grassland when settlement of the county began and partly covered by jack pine and Norway pine. Nearly 70 per cent of it has been brought under the plow.

Dorset sandy loam in most respects rather closely resembles Hubbard sandy loam but has more relief, ranging from gently rolling to rolling, and carries more stone, a few cobbles and small boulders at the surface and numerous cobbles below. In some places the stones are numerous enough to interfere with cultivation. In general, the surface layer of Dorset sandy loam is slightly deeper, finer in texture, and less acid than that of Hubbard sandy loam. The farmers of the district consider it the more productive of the two types.

Todd sandy loam occupies a somewhat greater acreage than the Hubbard and Dorset soils together. The most of it is found south of the central ridge, adjacent to these two types, but a few small tracts are found north of the ridge. Almost a third of it has been brought under the plow, and in acreage of crop land it is surpassed by the Hubbard soils only and in the proportion in crop by the Hubbard and Dorset soils only. The relief ranges from level to rolling, in a few places being sharply rolling. In virgin condition it had a cover of jack and Norway pine with some bur oak, aspen, and birch.

The profile of the Todd sandy loam, shown in Table 12, is quite similar to that of Hubbard sandy loam, except for the light color of its surface layer, which is brownish gray, 6 to 12 inches in thickness, and generally free of pebbles and larger stones. Below this is a 10- to 18-inch layer of sandy loam or loamy sand with many pebbles, which, like the corresponding layer in the Hubbard loamy sand, is known locally as "hardpan"; in some places it carries much iron-cemented sand in the form of small pockets or narrow horizontal bands. Under this is a deep bed of loose, gravelly sand, usually in alternating layers of coarse sand and gravel with some admixture of cobbles and small boulders. On the knolls and ridges cobbles and pebbles are found at the

surface. While this type is usually free of boulders, there are a few small patches with enough stone in the surface layer to interfere seriously with cultivation.

A variation from the above-described profile is found on a rather extensive, nearly level area, in the northeastern part of Badoura Township, where the uppermost layer averages only 6 inches in thickness and a uniform, horizontal 2- to 3-inch layer of pebbles and small cobbles separates it from the sandy loam layers with pebbles.

As an agricultural soil, Todd sandy loam is inferior to the Hubbard and Dorset sandy loams, its surface layer being much poorer in nitrogen and usually less retentive of moisture. In general, it is more acid than the Dorset sandy loam but less acid than the Hubbard soils.

Marquette sandy loam is found chiefly on or adjacent to the central ridge, the largest tracts being near the Mantrap chain of lakes, the relief ranging from gently rolling to very hilly. While this soil type is about as extensive as the Hubbard soils, somewhat less than a tenth as much has been brought under cultivation and this on the more level areas. The natural vegetation is like that of the Todd sandy loam—jack pine with some Norway pine, aspen, birch, and bur oak.

Marquette sandy loam has a surface layer of grayish-yellow, loose sandy loam, about 6 inches in depth, below which is an 8- to 16-inch layer of reddish brown sandy loam, sticky when wet and compact when dry, which in turn is underlain by sand and gravel with cobbles and boulders. In a few places the second layer is much thicker, even 24 to 30 inches. Marquette sandy loam is as poor in nitrogen and as drouthy as Todd sandy loam, from which it differs chiefly in carrying a great amount of stone at the surface and below and being much rougher. Stones of all sizes, from large boulders to cobbles, are numerous throughout the entire profile, especially at the surface on the slopes and hilltops of the rougher areas, where erosion has removed the finer material. In many places the boulders at the surface are so numerous as to render the land unfit for cultivation.

Light Sandy Soils

The light sandy soils occupy about a sixth of the county and are widely distributed, largely in small detached tracts (Fig. 19). There are two rather large areas, the one extending from Lake George on the north side of the central ridge to the Beltrami County line, with heavy soils on both sides, and the other lying in the southeastern corner of the county, bordered on the north and west by sandy loams.

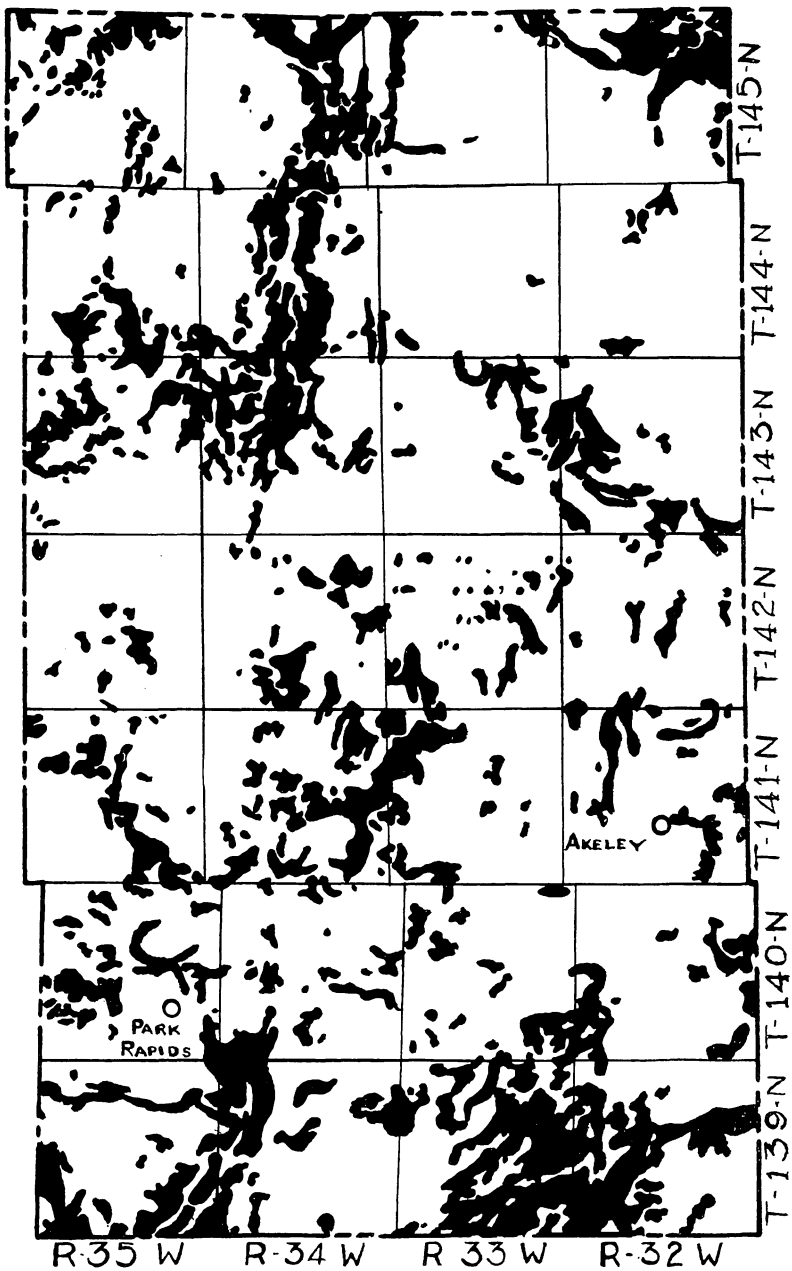

Fig. 19. Distribution of Light Sandy Soils

Soil type	Acres	Per cent of county	Per cent in crop land
Nymore loamy sand	7,552	1.3	26
Nymore sandy loam	5,248	0.9	42
Menahga loamy sand	52,864	8.8	9
Kinghurst loamy sand	8,128	1.4	8
Cass Lake fine sand	2,688	0.4	11
Arago loamy sand	21,120	3.5	4
Marquette loamy sand	10,560	1.8	4
Group	108,480	18.1	10

These soils resemble those of the sandy loam group in having coarse-textured subsoils but differ from them in having as well a coarse-textured surface, which is not retentive of moisture, is subject to drifting, and provides a poorer seedbed for small seeds, such as those of the clovers and alfalfa. While the subsoil in all the members of this group is coarse, it varies from a deep, comparatively uniform sand in the Nymore and Cass Lake soils to a mixture of sand with gravel, cobbles, and boulders in Marquette loamy sand (Table 13).

Table 13

Typical Profiles of Light Sandy Soils in Virgin Condition

Horizon	Depth, inches	Nymore loamy sand	Depth, inches	Menahga loamy sand	Depth, inches	Kinghurst loamy sand
A_0		Forest floor		Forest floor		Forest floor
A_1		*	0-2	Brown loamy sand	0-2	Brown loamy sand
A_2	0-5	Grayish-brown loamy sand	2-7	Gray loamy sand	2-8	Gray loamy sand with scattered boulders
B	5-15	Light grayish-brown sand	7-16	Yellowish-brown loamy sand	5-13	Brownish-yellow fine sand with scattered boulders
C	20+	Gray loose sand with fine gravel	16+	Brownish-gray loose sand with a few pebbles	18+	Brownish-gray loose sand with scattered boulders

Horizon	Depth, inches	Cass Lake fine sand	Depth, inches	Arago loamy sand	Depth, inches	Marquette loamy sand
A_0		Forest floor		Forest floor		Forest floor
A_1	0-1	Light brown loamy fine sand	0-1	Brown loamy sand	0-1	Brown loamy sand
A_2	1-5	Gray floury fine sand	1-14	Brownish-gray loose sand with cobbles and scattered boulders	1-15	Grayish-brown loose sand with much stone
B	5-13	Brownish-yellow fine sand	14-31	Grayish-brown coarse sand with cobbles and some boulders	15-27	Reddish-brown loose sand and gravel with much stone
C	20+	Yellowish-gray fine sand with some gravel	31+	Yellowish-gray loose mixture of sand and gravel with many cobbles and some boulders	27+	Yellowish-brown sand and gravel with much stone

* Horizons A_1 and A_2 not distinctly separated.

In their virgin condition they were covered with jack pine, with some Norway pine, but some areas of Nymore may have been in open grassland when settlement began. At present, second-growth jack pine

largely occupies the land not under cultivation, including some fields formerly in crop.

Marquette loamy sand is so stony that it is entirely unsuited for farming, and Arago loamy sand is so rough that the small tracts of it that have been brought under cultivation are practically limited to the immediate vicinity of lake resorts, where improved land is needed for the production of milk and vegetables and better soil was not available or was avoided because more difficult to clear of stumps and boulders. Kinghurst loamy sand carries some boulders at the surface, but the Nymore, Menahga, and Cass Lake soils are free of stone, level to gently undulating, and comparatively easy to free of stumps because occupied almost exclusively by jack pine. A third of the area of the Nymore soils has been brought under the plow, and about a tenth of each of the Menahga, Cass Lake, and Kinghurst soils. While comparatively inexpensive to put into cultivation, all four are very drouthy and when exposed to the sweep of the wind drift readily.

The nitrogen supply of these sands is low when first brought under cultivation, and under the "traditional system" of farming declines rapidly, so that after a few years of cropping the soils reach what is commonly referred to as a "worn-out" or "exhausted" condition, unless unusual amounts of stable manure are to be had or commercial fertilizers are used. The light crops of grains, timothy, and the common clovers, even where supplemented by wild hay from nearby bogs, do not allow the production of sufficient manure to supply the nitrogen needed by the small grains and cultivated crops. Ordinarily the common clovers do not do well on these soils; when they are sown with the small grains it is difficult to secure a stand except in unsually wet seasons, and even with good stands the yield of hay is light except in seasons with a rainfall more favorable than the average. Thus they require two wet seasons in succession. The experience of the settlers who have farmed these sandy soils has, in general, been very discouraging. Altho the Nymore, Cass Lake, and Menahga soils show a greater response to what may be called "improved methods" than do the naturally more productive soils, even with the adoption of these methods, which involve the use of alfalfa as the main crop, as described later in this report, these sandy soils are, at best, to be regarded as of low grade for agriculture.

The lime supply is on the whole quite favorable, and on few fields is it likely to be necessary to use lime or marl to prepare them for alfalfa or sweet clover. The supply of potash and phosphate is moderate, much as in the sandy loams. Phosphate fertilizers usually cause no distinct increase in crop yields, but potash fertilizers are often of

marked benefit, especially on alfalfa and the clovers. Sulfur fertilizers are very important, more so for alfalfa than for the clovers (see p. 107).

Nymore loamy sand and Nymore sandy loam. Nymore loamy sand and the very similar Nymore sandy loam, confined to the southern townships (Fig. 20), have been more largely brought under cultivation than any of the other sandy soils and probably should be regarded as naturally the most productive of this group. While the typical Nymore sandy loam has a somewhat finer-textured subsoil, and so is more retentive of moisture than the typical Nymore loamy sand, the areas of the two types as mapped in the county are so intermixed, with transitions from one to the other, that the description of the one is applicable to the other. About a third of their acreage has been brought under the plow, but few farms are located entirely on these soils.

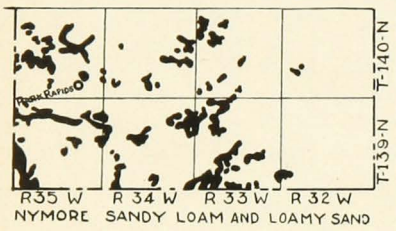

Fig. 20. Distribution of Nymore Soils

The Nymore soils are practically free of stones and in relief range from nearly level to gently rolling (Fig. 21). The surface 10 inches is a very dark grayish-brown loamy sand or sandy loam, lighter in color than that of the adjacent Hubbard soils. Below this is 10 to 15 inches of loamy, medium to coarse sand, light grayish-brown, or in some places light reddish-brown, when dry more coherent than the surface layer and

Fig. 21. The Nymore Soils are Level or Gently Undulating and are Naturally Covered With Jack Pines With a Few Norway Pines

when wet slightly sticky. No abrupt change in either color or texture is to be observed in passing to this from the surface layer. Below the above two layers, beginning on the average about 24 inches below the surface, is a deep bed of loose sand with more or less gravel and small pebbles. The color of this is yellowish-brown to grayish-yellow, which with increasing depth changes to gray.

Menahga loamy sand. Menahga loamy sand, the most extensive of the sandy soils, is widely distributed, the largest bodies being found in the northwestern and southeastern townships (Fig. 22). Less than a tenth of it has been cleared and plowed, the largest acreages being in Badoura and Crow Wing townships. At the time of the survey, 1929 and 1930, only a few farms on this soil type were being operated, there being many unoccupied houses and unused fields (Fig. 23).

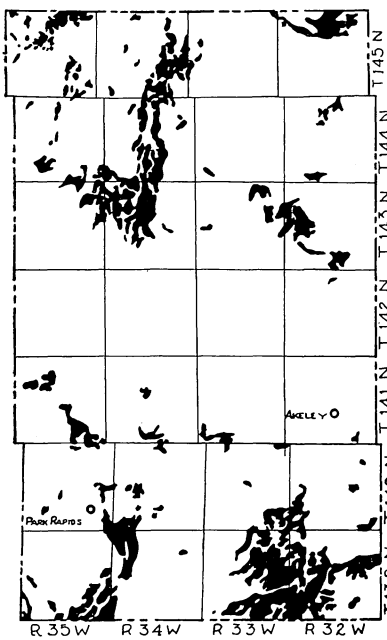

Fig. 22. Distribution of Menahga Loamy Sand

Menahga loamy sand differs from the Nymore soils in having a much lighter-colored surface soil, which is more poorly supplied with nitrogen and organic matter and also in having a somewhat coarser texture both in the surface layer and below.

The relief ranges from level to gently rolling, the latter usually adjacent to drainage ways. Stone is absent from surface and below, except in a few places with prominent relief where small cobbles are abundant.

While the Menahga loamy sand is typically a very drouthy soil, there are places where the water table is exceptionally close to the surface, usually adjacent to the poorly-drained Sebeka loamy sand, and in such locations surprisingly good crops may be found in dry seasons.

Kinghurst loamy sand. Kinghurst loamy sand, which occupies 8,128 acres, is found in the form of small areas in about two-thirds of the townships (Fig. 24). About a twelfth of it has been converted to crop land, but few if any farms are located entirely on this type. The relief is generally undulating or gently rolling.

This soil type is quite similar to the Menahga loamy sand, from which it differs chiefly by having scattered boulders, large and small,

both at the surface and below, and in having, within five or six feet of the surface, boulder clay, such as forms the substratum of the Rockwood soils. The boulders at the surface are usually less numerous and the sand layer is thicker than on the Rockwood loamy sand, to which

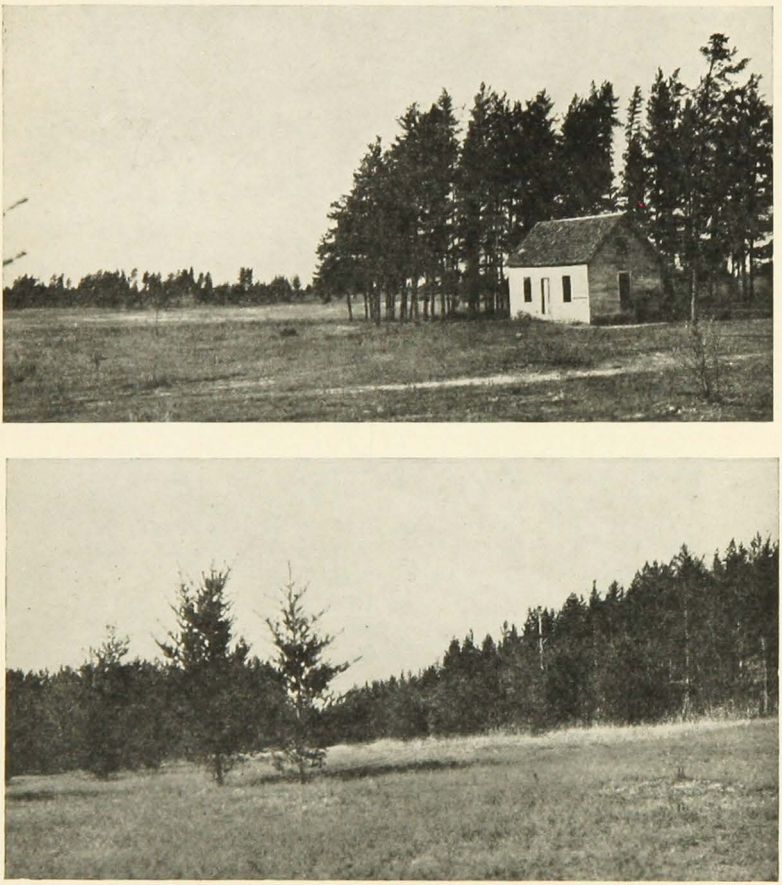

Fig. 23. Above, Unused House and Idle Fields in 1932; Below, Jack Pines Taking Possession of Field Formerly Under Cultivation

Experience of farmers on Menahga loamy sand has, in general, been very discouraging.

the Kinghurst loamy sand may be considered to form a transition from the Menahga loamy sand. In most places the heavy subsoil is too far below the surface to improve the moisture supply for crops other than possibly alfalfa. No fields of this crop were observed on this soil in the course of the survey.

Cass Lake fine sand. Cass Lake fine sand occupies less than one two-hundredth of the county and is confined to the extreme north-

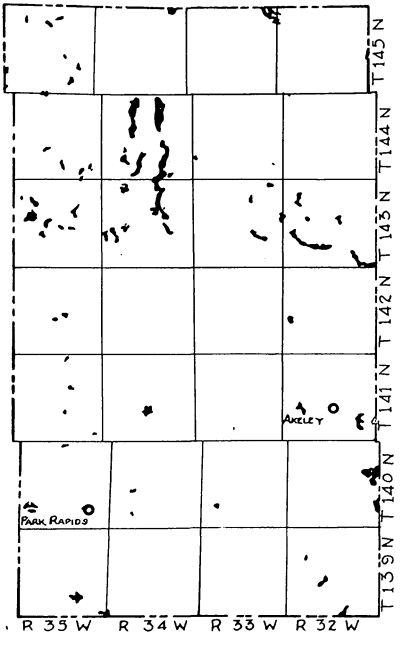

Fig. 24. Distribution of Kinghurst Loamy Sand

eastern corner (Fig. 25). About a ninth of it is in crop land.

It is free of stones larger than small pebbles and has a gently rolling to rolling surface. The plowed fields are quite subject to drifting. In agricultural value it may be considered somewhat inferior to the Nymore soils but probably superior to Menahga loamy sand.

Arago loamy sand. Arago loamy sand, which covers about a thirtieth of the county, occurs in small tracts, widely scattered, except for a rather large area in Lake Emma and Mantrap townships, among the lakes on the south side of the central ridge. (Fig. 26). It has a rough and hilly surface interrupted by many lakes and small bogs, which interfere seriously with its use for farming. Its topography, which may be described as "choppy," distinguishes it from the other sandy soils in Hubbard County. Only about 800 acres on this soil type have been brought into cultivation, and this on the smoother areas, chiefly in connection with summer resorts.

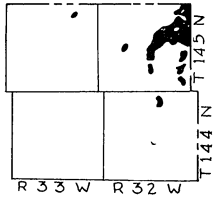

Fig. 25. Distribution of Cass Lake Fine Sand

Boulders are not very numerous at the surface except on areas with the sharpest relief. Under an 8- to 10-inch surface layer of light brownish-gray, or loose, loamy medium to coarse sand is a 10-inch light reddish-brown, slightly cemented mixture of coarse sand, pebbles, and cobbles, and under this a loose mixture of sand, gravel, pebbles, cobbles, and boulders the proportion of boulders and cobbles varying much within short distances. In a few places the substratum is free of boulders and cobbles, in this respect resembling that of the Menahga loamy sand, but in topography being very different.

Marquette loamy sand. Marquette loamy sand (Fig. 27), found chiefly in association with the Rockwood stony sandy loam on the central ridge, is rough and hilly, with boulders numerous at the surface

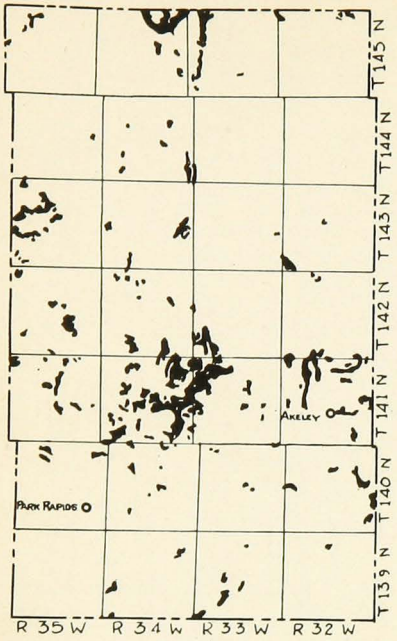

Fig. 26. Distribution of Arago Loamy Sand

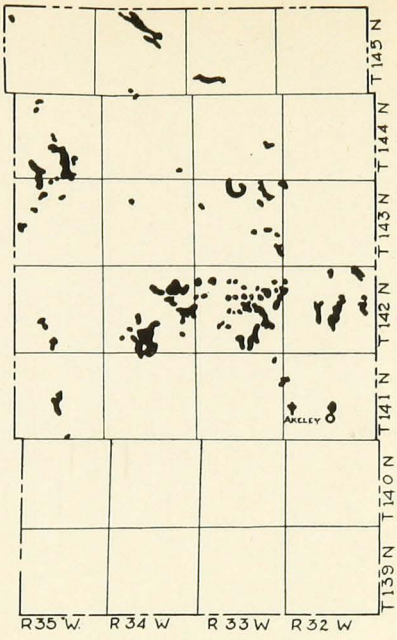

Fig. 27. Distribution of Marquette Loamy Sand

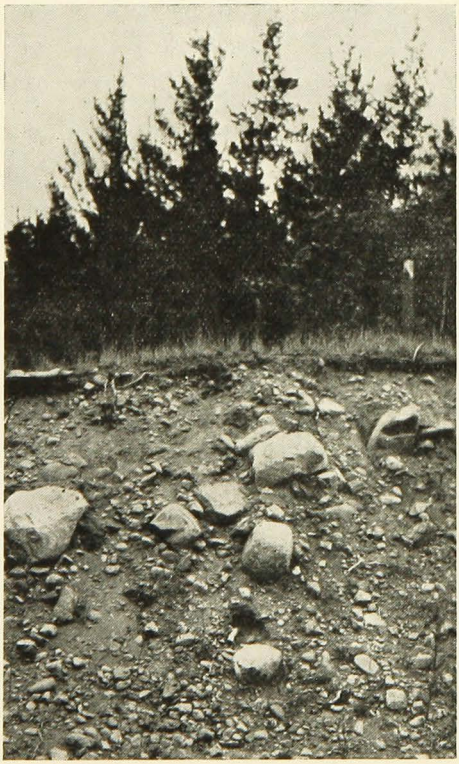

Fig. 28. A Road Cut Through Marquette Loamy Sand, Showing Large and Small Boulders and Many Cobblestones

and below. Little of it is in crop land. The surface 8-inch layer consists of loose, gravelly, cobbly, loamy sand overlying a bed of loose gravelly sand with many cobbles and boulders (Fig. 28). In many places gravel pits have been opened for highway use.

Sandy Soil With Heavy Subsoil

Rockwood loamy sand is the only representative of this group. It occupies 34,432 acres, or 5.8 per cent of the county, occurring in many scattered tracts, chiefly in the four northwestern townships and in the vicinity of Akeley (Fig. 29), usually adjacent to Rockwood sandy loam. About a tenth of it has been brought under the plow.

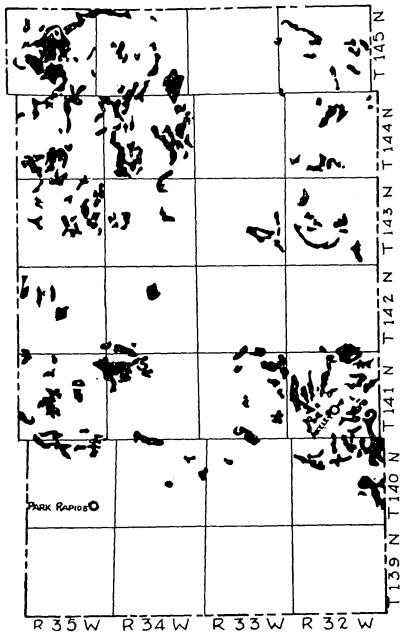

Fig. 29. Distribution of Rockwood Loamy Sand

On the Rockwood loamy sand the first two to four feet resembles the light sands, consisting of sand or loamy sand, below which is a subsoil of boulder clay similar to that of the Rockwood sandy loam and Rockwood loam. Accordingly, in crop response it is intermediate between the light sands, on the one hand, and Rockwood sandy loam, on the other, in general behavior, but much more like the former, being drouthy toward most crops and subject to drifting. At most places on the Rockwood loamy sand, boulders are found both at the surface and in the sandy layer overlying the heavy subsoil, in some places being as numerous and

Table 14

Three Typical Profiles of Rockwood Loamy Sand in Virgin Condition

Horizon		Depth of horizon		
		Profile 1, inches	Profile 2, inches	Profile 3, inches
A_0	Forest floor	....	....	....
A_1	Brown loamy sand	0-1	0-2	0-1
A_2	Grayish-yellow loose sand with a few cobbles and boulders	1-15	2-24	1-37
B	Reddish-brown sand with scattered boulders	15-24	24-36	37-48
C	Yellowish-gray sandy clay with cobbles and boulders	24+	36+	48+

large as on the more stony areas of the Rockwood sandy loam. In relief it varies from gently rolling to steep and hilly.

Rockwood loamy sand resembles Kinghurst loamy sand in having a coating of sand over the boulder clay subsoil, but the coating is not as thick as on the latter. The productivity of this soil for the usual farm crops varies inversely as the depth of the sand layer, approaching that of the Rockwood sandy loam where this is the most shallow, but usually being more like that of the light sands dealt with above. Alfalfa is likely to prove the most productive crop on Rockwood loamy sand and may be found to produce about as well as on the heavier soils.

Rough Stony Land

Rockwood stony sandy loam, the only member of this group, has an area of 108 square miles, almost an eighth of the county. It is limited to the central ridge, the most of which it occupies in an almost solid body (Fig. 30), associated with rough areas of Arago loamy sand, Marquette loamy sand, Marquette sandy loam, and Rockwood sandy loam. Less than one per cent of it has been converted into crop land, and this small part is now almost exclusively in grass.

Rockwood stony sandy loam has a profile so similar to that of Rockwood sandy loam that it might be treated simply as a very rough phase of the latter soil type, but here it is separated as a distinct type and shown by a distinctive color on the soil map because it differs so greatly in economic value, being quite unfit for agriculture. It is very rough and hilly, the topography being characterized by an alternation of steep hills with deep depressions, or potholes, occupied by ponds or small peat bogs (Fig. 31).

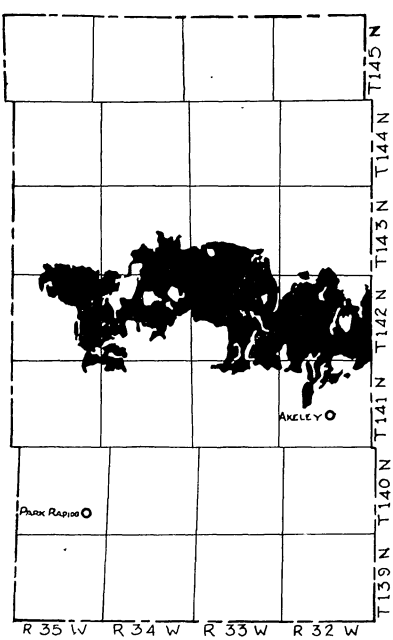

Fig. 30. Distribution of Rockwood Stony Sandy Loam

Altho stones appear no more numerous in the profile, as exposed in road cuts, than on the Rockwood sandy loam, boulders are much more prominent on the surface, standing out on the succession of hill crests and steep slopes. This difference may be

attributed to the much greater erosion that has taken place on these hills than on the smoother Rockwood sandy loam, the clay, silt, and sand having been washed down the slopes and deposited in the depressions, where this fine material now lies at the bottom of bogs under a cover of peat.

The surface is too rough for farming, in addition to being very stony.

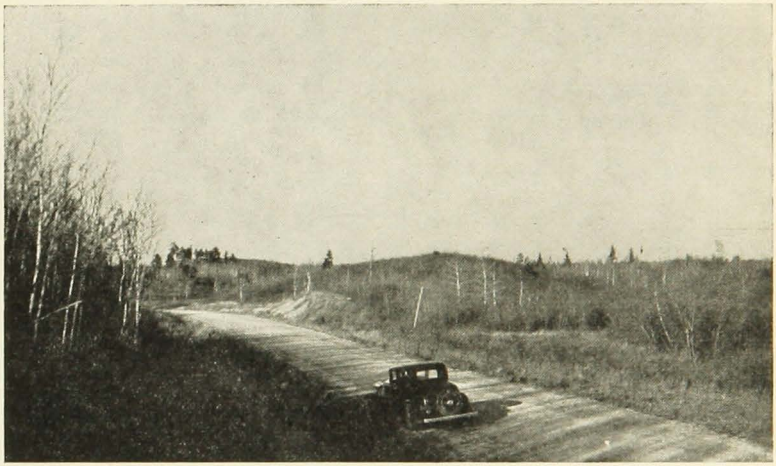

Fig. 31. Rockwood Stony Sandy Loam

Poorly-Drained Mineral Soils

The poorly-drained mineral soils occupy scarcely a fortieth of the county, but occur in small isolated tracts in every township, in many places associated with peat. Bluffton loam is found among the heavy soils, Sebeka loamy sand in the shallow depressions of the sandy loams and light sands, mixed stream deposits along the streams, and beach sand along the shores of the larger lakes.

The first three soils were originally occupied mainly by willow, alder, aspen, birch, and some black ash, with brushy grass meadows on

Soil type	Acres	Per cent of county
Bluffton loam	6,912	1.1
Sebeka loamy sand	5,056	0.8
Mixed stream deposits	2,496	0.4
Beach sand	320	0.1
Group	14,784	2.4

the wettest parts. In ordinary seasons they are too wet to be cultivated or to grow crops other than grasses, except where they have been provided with artificial drainage. Where cleared, they are used almost exclusively as pastures or as wild-hay meadows. The occurrence on a farm of a limited acreage of these soils may considerably enhance rather than depress its value, because they are comparatively easy to clear and are more productive of grass than the adjacent well-drained soils, both in seasons of normal rainfall and in dry seasons.

Bluffton loam. Bluffton loam is widely distributed in small areas, chiefly north of the central ridge. It occupies depressions among the Rockwood and Nebish soils, either where the drainage has not been poor enough to favor the development of peat or where the original covering of peat has been burned off. Where the surface has not been disturbed it has a 2- or 3-inch layer of organic matter—leafmold, muck, or peat. Below this there is a 3- to 5-inch layer of black silty clay, under which is a 6- to 12-inch dark gray sandy loam or sandy clay mottled with iron stains, this in turn resting on gray clay loam or sandy clay. On most of the areas, boulders and cobbles are rather numerous both at the surface and below. Bluffton loam, as mapped, shows wide variations, the surface soil ranging in texture from sandy loam to heavy clay loam and in color from grayish-yellow to black.

Sebeka loamy sand. The most of this soil occurs among the sandy loams and light sands as small tracts in the depressions not occupied by peat. The large area in Badoura Township and many of the smaller tracts are the result of fires which have burned off all or nearly all of the original peat covering. Only a very small part of the Sebeka loamy sand has been brought under the plow. The water table is usually found within four feet or less of the surface. In most places boulders are absent.

Below a one- to two-inch layer of organic matter three layers are recognizable. Uppermost is about three inches of grayish-brown, loose loamy sand, then four to eight inches of slightly cemented grayish-brown loamy sand, with stains of brown, orange, and yellow, and lastly a loose, loamy sand, in which the color changes with increasing depth from a mottling like the preceding to a bluish-gray. In some places thin layers of bog iron ore are found.

Mixed stream deposits. These border the Mississippi River along its entire course within the county, about six miles in Fern Township, and are found along most of the other streams and many of the intermittent water courses. The character of both surface and subsoil varies widely within short distances, ranging from black, heavy

silty clay to clean river-washed sand, with here and there small patches of peat. They are subject to flooding during periods of high water. Where cleared, the land is used almost exclusively as pasture or wild hay meadow.

Beach sand. Beach sand is found along the shores of most of the larger lakes and of some former lakes that now are dry. It occupies only 320 acres and none of it is under cultivation.

The surface consists of gray, loose, coarse sand, often carrying gravel or cobbles and at times even boulders. In some places the sand forms only a shallow coating over fine-textured material, while in others it is covered by a thin layer of peat or muck. The water table is usually near the surface and in wet seasons much of the beach sand is flooded.

Physical and Chemical Characteristics of the Mineral Soil Types

A laboratory examination was made of samples of surface soil representing 16 of the mineral soil types. Each sample, representing a field, was prepared by combining 10 to 20 individual samples of approximately equal weight, taken at intervals of 10 to 15 yards, usually in a straight line, to a depth of 4 or 5 inches, to represent the soil turned by the plow. Two hundred and thirteen fields were sampled, the Hubbard soils providing 42; Rockwood sandy loam, 33, and the other types, smaller numbers. All the fields had been under cultivation long enough to have lost the marbled appearance commonly observed on newly broken land. The samples were not collected until the soil map had been made and then not for the purpose of showing what is regarded as most typical of each type but in order to learn what range in properties may be expected in the various types as they have been mapped in Hubbard County. Determinations were made of the water-retaining capacity and the fineness of texture, as indicated by the moisture equivalent, of the acidity, and of the nitrogen content. Also the colors of the soils were compared.

Texture and water-retaining capacity. The fineness of texture and the capacity to retain moisture are indicated by the moisture equiv-

Soil type	Number of samples	Soil type	Number of samples
Rockwood sandy loam	33	Nymore sandy loam	6
Rockwood loam	11	Nymore loamy sand	10
Nebish loam	17	Menahga loamy sand	22
Beltrami silt loam	6	Kinghurst loamy sand	6
Hubbard sandy loam	38	Cass Lake fine sand	6
Hubbard loamy sand	4	Arago loamy sand	5
Dorset sandy loam	10	Rockwood loamy sand	10
Todd sandy loam	21		
Marquette sandy loam	5		

alent[4] which may be as low as 1 or 2 with coarse sands and gravelly sands and as high as 40 or even more with very heavy clay loams. The finer the texture of a soil, that is to say the more clay and silt it contains, the higher will be its moisture equivalent. The amount of moisture remaining in a well-drained fallow soil two or three days after a heavy rain, the surface having been protected from evaporation during the interval, is approximately equal to the moisture equivalent. Accordingly, the determination of this value gives us not only an idea as to the relative fineness of texture but also a satisfactory expression of the capacity of the soil to retain water. Only in the case of the lightest soils is there a marked difference between the moisture equivalent and the water-retaining capacity; in these the movement of water from the surface layer into the subsoil comes to an end so slowly that the water remaining in the surface layer at the end of several days may be considerably higher than the moisture equivalent. However, the amount of water retained by these light soils is at best so small that this difference is of relatively little importance in the present comparisons.

The moisture-equivalent data are summarized in Table 15. In the group of heavy soils the values range from 7 to 26, those of Rockwood sandy loam from 7 to 19, about an eighth being above 15, with an average of 13 for all. Those of Rockwood loam range from 9 to 19, about half above 15, with an average of 14, while Nebish loam shows a range from 12 to 18, also with about half above 15, and an average of 16. The five samples of Beltrami silt loam show a range from 9 to 26, with an average of 17; the low values of three, viz., 9, 9, and 14, are to be attributed to the difficulty of securing from cultivated fields samples really representative of this soil type, owing to its seldom forming the whole of a field, while its surface does not appear distinctly unlike that of the other heavy types after the latter have been freed of stone. It is evident that Rockwood loam and Nebish loam have in general a finer-textured surface soil than Rockwood sandy loam but that on areas of any one of these three types shown on the accompanying colored soil map, there may be found fields or parts of fields which resemble either of the other two types.

In the sandy loam group the moisture equivalents of Hubbard sandy loam range from 8 to 18, with an average of 12; those of Hubbard loamy sand from 10 to 13, also with an average of 12; those of Dorset from 9 to 14, with an average of 13, and those of Todd from 7 to 14, with an average of 9.

[4] A weighed amount of soil is saturated with water and then the excess thrown off by whirling in a centrifuge for 40 minutes at a speed of 2,400 revolutions per minute. The amount of water so retained by 100 parts of dry soil is known as the *moisture equivalent*.

Table 15

Moisture Equivalents of Surface Soils

Soil type	Moisture equivalents		Percentage with value above 15
	Range	Average	
1. Medium to heavy loams			
Rockwood sandy loam	7 to 19	13	12
Rockwood loam	9 to 19	14	55
Nebish loam	12 to 18	16	56
Beltrami silt loam	9 to 26	17	50
2. Sandy loams			With value above 12
Hubbard sandy loam	8 to 18	12	29
Hubbard loamy sand	10 to 13	12	25
Dorset sandy loam	9 to 14	13	60
Todd sandy loam	7 to 14	9	5
Marquette sandy loam	7 to 17	10	20
3. Light sands			With value above 8
Nymore sandy loam	6 to 9	8	33
Nymore loamy sand	7 to 11	9	40
Menahga loamy sand	4 to 9	6	13
Kinghurst loamy sand	5 to 12	8	50
Cass Lake fine sand	5 to 8	7	33
Arago loamy sand	7 to 16	9	40
4. Light sand with heavy subsoil			With value above 8
Rockwood loamy sand	5 to 14	7	20

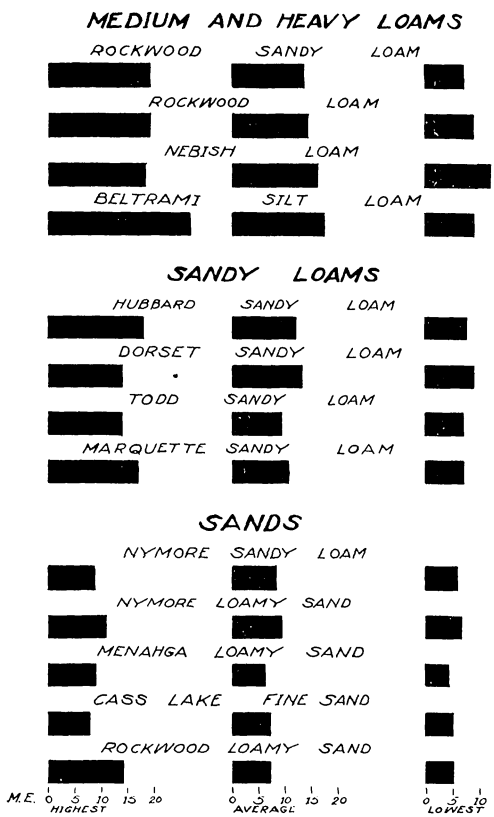

Fig. 32. Moisture Equivalents of Surface Soils From Fields in Cultivation Showing the Highest, Average, and Lowest Values Found for Each Soil Type

In the group of light sands the moisture equivalents average about half as high as those of the group of heavy loams and two-thirds as high as those of the sandy loams. Menahga loamy sand and Cass Lake fine sand have the coarsest texture and are least retentive of moisture.

The surface soil of Rockwood loamy sand, which has a heavy subsoil, has as low a water-retaining capacity as the light sands with coarse subsoils.

Figure 32 shows graphically for each soil type the highest and the lowest moisture equivalent found, as well as the average.

It is in the subsoil that the most striking differences in water-retaining capacity are found. Figures 33 and 34 show the mois-

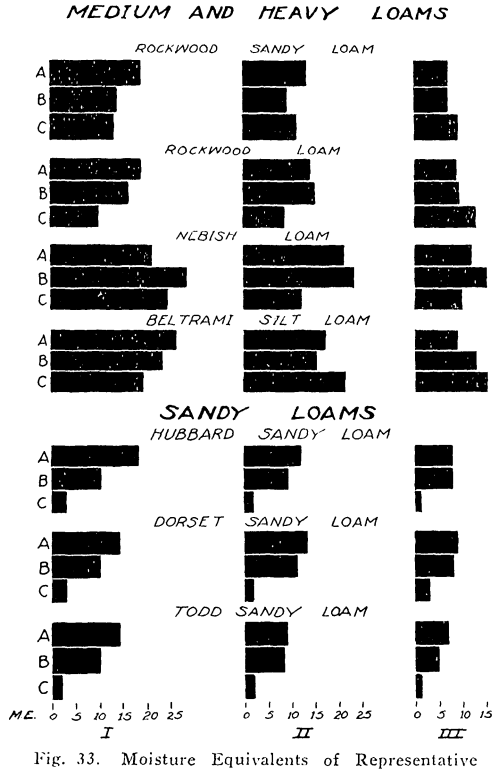

Fig. 33. Moisture Equivalents of Representative Profiles of the Various Soil Types in the Heavy and Sandy Loam Groups

II. Represents the most common profile, I the finest-textured and most retentive of moisture, and III the coarsest-textured and least retentive of moisture. A, surface soil; B, upper subsoil; C, lower subsoil.

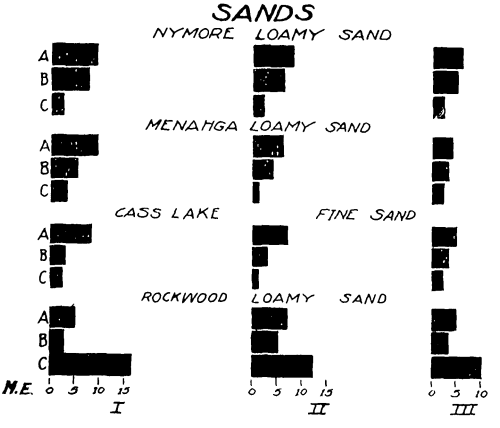

Fig. 34. Moisture Equivalents of Representative Profiles of the Sands

A, surface soil; B, upper subsoil; C, lower subsoil.

ture equivalents of the upper subsoil (B) and lower subsoil (C) as well as of the surface soil (A) for 11 soil types. In the case of each type, the graph on the left represents the profile with the finest-textured subsoil commonly found, that on the right the one with coarsest texture, while the center one is intermediate and may be considered representative of the average. The values used for the accompanying surface sections are not those of samples taken at the same places as the subsoils shown but are those reported in Table 15, the maximum on the left, the minimum on the right, and the average in the center. As to the moisture retentiveness of the soil types not included, the Nymore sandy loam is similar to the Nymore loamy sand, the Marquette sandy loam resembles the Todd sandy loam, and the Marquette and Arago loamy sands resemble the Menahga loamy sand. The intermediate position of the subsoil of Kinghurst loamy sand, between that of Menahga loamy sand and that of Rockwood loamy sand, has been mentioned above.

Nitrogen content. The nitrogen of a mineral soil is contained chiefly in the

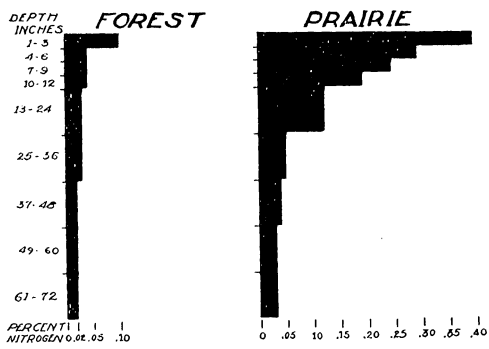

Fig. 35. Distribution of Nitrogen in Representative Virgin Forest and Prairie Profiles

surface layers, especially in forest soils, in which the natural supply is low. The difference between forest soils and prairie soils is well illustrated by Table 16 and Figure 35, which show the distribution of nitrogen in representative heavy soils, one in Koochiching County, bearing a heavy growth of hardwoods and conifers, and the other in a field of virgin prairie in Yellow Medicine County.

All four members of the group of heavy loams are similar in nitrogen content, which ranges from a minimum of 0.04 per cent to a maximum of 0.19, with an average of 0.10 per cent in the case of each (Table 17).

Table 16

Nitrogen Content of Representative Virgin Forest and Prairie Soils

Depth of section	Percentage of nitrogen		Pounds of nitrogen per acre	
	Forest field	Prairie field	Forest field	Prairie field
1-3 inches	0.10	0.39	523	2,378
4-6 inches	.04	.29	331	2,021
7-9 inches	.04	.24	366	1,777
10-12 inches	.04	.19	366	1,490
Second foot	.03	.12	1,050	3,768
Third foot	.03	.05	1,380	1,742
Fourth foot	.02	.04	969	1,394
Fifth foot	.02	.03	969	1,045
Sixth foot	.02	.03	969	1,045

In the sandy loam group the Dorset and Hubbard soils are much alike in nitrogen content, the former having an average of 0.13 per cent and the latter 0.14 per cent, with a wider range, 0.07 to 0.23 per cent, while Todd is lowest, with an average of only 0.07 per cent, and a range of 0.04 to 0.10 per cent. Thus the sample of Todd soil richest in nitrogen contains no more than the poorest of the Dorset samples.

All the light sand types are much alike in nitrogen, with averages of 0.05, 0.06 or 0.07 per cent, and show much the same range, with extremes, for the group, of 0.02 and 0.10 per cent. In this respect they resemble Todd sandy loam, which has an average of 0.07 per cent and a range of 0.04 to 0.10 per cent.

Table 17

Nitrogen Content of Surface Soils

Soil type	Nitrogen content	
	Range per cent	Average per cent
1. Medium to heavy loams		
Rockwood sandy loam	0.04 to 0.19	0.10
Rockwood loam	.06 to .15	.10
Nebish loam	.07 to .14	.10
Beltrami silt loam	.06 to .14	.10
2. Sandy loams		
Hubbard sandy loam	0.07 to 0.23	0.14
Hubbard loamy sand	.09 to .13	.10
Dorset sandy loam	.10 to .16	.13
Todd sandy loam	.04 to .10	.07
Marquette sandy loam	.04 to .16	.09
3. Light sands		
Nymore sandy loam	0.02 to 0.10	0.06
Nymore loamy sand	.05 to .10	.07
Menahga loamy sand	.02 to .09	.06
Kinghurst loamy sand	.04 to .09	.06
Cass Lake fine sand	.03 to .07	.06
Arago loamy sand	.05 to .09	.06
4. Light sand with heavy subsoil		
Rockwood loamy sand	.03 to .09	.05

Organic matter content. The plant residues in the surface soil, more or less completely altered through the action of bacteria and fungi, are spoken of as the *organic matter* of the soil, or, less accurately, as the *humus*. The organic matter has a beneficial effect upon the soil structure, making heavy soils more granular and accordingly easier to work, while on the light soils it helps to bind the individual sand grains into crumbs and so lessens the tendency of the soil to drift with the wind. It also increases the water-holding capacity of the soil, but the quantity of organic matter present is ordinarily so small that the effect of variations in the amount is small compared with that of variations in the texture. In the case of the Hubbard County soils, the organic matter was not directly determined, but it can be satisfactorily estimated as 20 times the amount of nitrogen, the ratio of organic matter to nitrogen in surface soils being practically constant. Thus in the case of the two soils reported in Table 16, the surface three inches of the forest soil, with 0.10 per cent of nitrogen, will carry 2.0 per cent of organic matter, while the prairie soil, with 0.39 per cent of nitrogen, will carry 7.8 per cent of organic matter. The averages for the various mineral soil types in Hubbard County range from 1.00 in the Rockwood loamy sand to 2.8 per cent in the Hubbard sandy loam.

In contrast to the mineral soils, peat soils consist chiefly of organic matter, which forms from 50 to 95 per cent of their weight when dry as illustrated in Table 24.

Acidity. Very strongly acid soils are generally unfavorable for the growth of many crop plants, the optimum condition for most crops

being a very slight acidity in the surface soil rather than a neutral or alkaline condition. Of the field crops grown in Hubbard County, alfalfa and sweet clover are most sensitive to acidity, alsike and red clover being much less sensitive, while small grains, corn, and potatoes are still less sensitive. If a soil has enough lime for alfalfa and sweet clover, it may be considered well enough supplied for all farm and garden crops. Where a soil is too acid for the successful growth of a crop, it may have its acidity neutralized by the application of sufficient lime, usually in the form of ground limestone or marl.

The acidity of the soil was determined by what is known as the potentiometer method and in Table 18 is expressed as "active acidity." Where the active acidity of one soil is reported as 100 and that of another as only 20, the former will be five times as strongly acid as the latter and accordingly much more likely to be in need of liming to make it suitable for alfalfa or sweet clover.

Table 18

Acidity of Surface Soils, Expressed as Active Acidity

Soil type	Range	Average	Proportion with value above 10 per cent	Proportion with value above 20 per cent
1. Medium to heavy loams				
Rockwood sandy loam	0 to 25	7	12	6
Rockwood loam	0 to 16	6	25	0
Nebish loam	0 to 20	5	12	0
Beltrami silt loam	0 to 6	0	0	0
2. Sandy loams				
Hubbard sandy loam	3 to 40	20	76	40
Hubbard loamy sand	1 to 31	11	25	25
Dorset sandy loam	4 to 10	8	0	0
Todd sandy loam	3 to 50	14	62	10
Marquette sandy loam	0 to 6	4	0	0
3. Light sands				
Nymore sandy loam	4 to 16	10	66	0
Nymore loamy sand	8 to 25	13	50	10
Menahga loamy sand	1 to 25	9	27	23
Kinghurst loamy sand	0 to 31	23	80	80
Cass Lake fine sand	4 to 20	13	66	0
Arago loamy sand	1 to 5	4	0	0
4. Light sand with heavy subsoil				
Rockwood loamy sand	4 to 20	10	50	0

The degree of acidity in the heavy soil group, much the same in the Nebish loam and the two Rockwood soils, ranges from 0 to 25, with an average of 7 for Rockwood sandy loam, 6 for Rockwood loam, and 5 for Nebish loam. Beltrami silt loam averages distinctly less acid, three of the five samples examined being slightly alkaline and the other two showing values of only 2 and 6. Of the sandy loams, the Marquette and Dorset soils average the least acid, Hubbard the most acid, and Todd intermediate. Among the light sands, the Kinghurst soils are on the average the most acid and the Arago the least, while the others

fall between these extremes with but few samples being found decidedly acid.

Comparing all the soil types, it will be seen that there is a considerable range in acidity shown by most of them and that the most acid samples are found on the Todd and Hubbard soils. One may conclude that on only a very small proportion of the fields of Hubbard County will liming be found necessary for alfalfa or sweet clover and these fields will be confined chiefly to the Hubbard and Todd soils.

The degree of acidity of the subsoil is usually of little importance where the surface soil has sufficient lime, but where the latter is deficient a liberal amount in the subsoil may enable alfalfa to give satisfactory yields without liming. Accordingly, where the surface soil is so acid as to indicate a probable lime deficiency, the degree of acidity of the subsoil becomes important. On most soil types the upper subsoil is less acid than the surface, and the lower subsoil is still less acid.

In Table 19 the acidity of the subsoil is reported for 46 profiles representing 13 soil types. In the group of heavy soils, the upper subsoil averages somewhat higher in acidity than the surface samples (Table 18), while the lower subsoil in most cases shows no acidity. Among the sandy loams, the Dorset subsoils show practically no acidity, while the upper subsoil of the Hubbard and Todd is less acid than the surface soil, and the lower subsoil is still more nearly neutral. The light sands are much like the sandy loams; the Kingshurst and Rockwood loamy sands include the most acid profiles, resembling the Hubbard sandy loam.

Table 19

Acidity Found in Subsoils of Different Soil Types

Soil type	Number of profiles examined	Active acidity			
		Upper subsoil (B)		Lower subsoil (C)	
		Range	Average	Range	Average
1. Medium to heavy loams					
Rockwood sandy loam	5	0 to 12	7	0 to 12	3
Rockwood loam	3	6 to 31	18	0 to 1	0
Nebish loam	4	0 to 20	7	0 to 0	0
Beltrami silt loam	2	0 to 14	7	0 to 0	0
2. Sandy loams					
Hubbard sandy loam	5	5 to 31	15	0 to 12	6
Hubbard loamy sand	2	5 to 6	5	0 to 5	3
Dorset sandy loam	3	1 to 2	1	0 to 0	0
Todd sandy loam	6	6 to 20	11	0 to 16	7
3. Light sands					
Nymore sandy loam	3	5 to 6	6	1 to 1	1
Nymore loamy sand	3	5 to 8	6	5 to 8	6
Menahga loamy sand	4	5 to 12	8	0 to 5	2
Kinghurst loamy sand	2	8 to 40	24	3 to 6	4
4. Light sand with heavy subsoil					
Rockwood loamy sand	3	6 to 40	19	10 to 16	13

While the acidity data reported in Tables 18 and 19 are in agreement with the experience of Hubbard County farmers who have sown alfalfa and sweet clover, indicating that for the county in general there is seldom need of liming, they further suggest that on Hubbard and Todd sandy loams, and to a less extent on the light sands, the farmers should give thought to the need of liming before sowing these crops.

Color. A color comparison of 213 samples was made by arranging small portions of all, in air-dry condition, in order of darkness of shade, so that those most nearly white were at one end and those nearest black at the other, then dividing them into 10 groups and giving the rank of 1 to the lightest group, represented by some samples of Beltrami silt loam and Nebish silt loam, and the rank of 10 to the darkest group, which consisted of a few Dorset and Hubbard samples. Differences were more marked in the air-dry than in the moist condition, as may be seen from Table 20.

Table 20

Comparison of Relative Shades of Color of Hubbard County Surface Soils in Air-Dry and in Moist Condition

Rank	Color when air dry	Color when moist*
1.....	Light gray with yellowish tint	Yellowish-gray
2.....	Light yellowish-gray	Dark yellowish-gray
3.....	Light yellowish-gray with light brown tint	Light brownish-gray
4.....	Light grayish-brown	Grayish-brown
5.....	Brown with slight reddish tint	Dark grayish-brown
6.....	Grayish-brown	" " "
7.....	Dark gray with light brownish tint	Dark brownish-gray
8.....	Light brownish-gray	" " "
9.....	Brownish-gray	" " "
10.....	Dark brownish-gray	Brownish-black

* At approximately the moisture equivalent.

There is a wide range in the case of each of the heavy types except the Beltrami silt loam, on which were found only the lightest shades, 1 to 3, with an average of 2 (Table 21). The Nebish loam shows a greater ranger, 1 to 6, with an average of 2, while the Rockwood loam shows the same range but has a higher average, 3. The Rockwood sandy loam, the darkest, has an average of 4, with a range of 3 to 7, and provides no representatives of the two lightest-colored groups.

The Hubbard and Dorset soils, all very dark, are similar, being dark-brownish gray to brownish-black when wet. They give the same average and show practically the same range, while the Todd soils in general are much lighter in color, and the Marquette soils are the lightest of all the sandy loams.

Of the light sands, the Nymore soils are the darkest and resemble the lightest samples of the Hubbard and Dorset sandy loams, while all the other light soils are still lighter in color but generally darker than the Nebish loam and Beltrami silt loam samples.

In soils of the same degree of fineness of texture the color becomes darker with increasing content of organic matter, and appears black with 6 per cent or more. As the amount of organic matter is proportional to that of nitrogen, the nearness of approach to a black color

Table 21

Relative Shade of Color of Surface Soils. 1 indicates the Lightest and 10 the Darkest Shade, the Most Nearly Black

Soil type	Darkness of shade	
	Range	Average
1. Medium to heavy loams		
Rockwood sandy loam	3 to 7	4
Rockwood loam	1 to 6	3
Nebish loam	1 to 6	2
Beltrami silt loam	1 to 3	2
2. Sandy loams		
Hubbard sandy loam	6 to 10	8
Hubbard loamy sand	7 to 9	8
Dorset sandy loam	7 to 10	8
Todd sandy loam	4 to 7	5
Marquette sandy loam	4 to 5	4
3. Light sands		
Nymore sandy loam	7 to 8	7
Nymore loamy sand	3 to 8	6
Menahga loamy sand	2 to 6	4
Kinghurst loamy sand	2 to 4	3
Cass Lake fine sand	2 to 5	4
Arago loamy sand	3 to 5	4
4. Light sand with heavy subsoil		
Rockwood loamy sand	1 to 5	3

generally varying with the content of nitrogen, the color of a soil may serve to indicate approximately its richness in nitrogen. However, this simple relationship does not hold true in the comparison of soils of widely different texture. The coarser the soil, the smaller the proportion of organic matter required to give it a dark color, as is well illustrated by the Rockwood loam and Rockwood loamy sand with average moisture equivalents of 14 and 7, respectively. These soils are equally dark in color, altho the latter carries only half as much organic matter as the former.

Summary Comparison of Soil Types

In Table 22 the soil types are arranged in the order of the average moisture equivalent. It will be seen that the surface of Hubbard and Dorset soils differs little in texture from that of Rockwood sandy loam or Rockwood loam, that it is very much darker in color and somewhat richer in nitrogen, while the Hubbard soils most frequently show a considerable degree of acidity. The Hubbard and Dorset surface soils are twice as rich in nitrogen and organic matter as the light sands and are able to retain from half as much again to twice as much water.

Table 22

Comparison of Properties of the Various Soil Types

Soil type	Nitrogen per cent	Color rank	Active acidity	Moisture equivalent
1. Medium to heavy loams				
Beltrami silt loam	0.10	2	..	17
Nebish loam	.10	2	5	15
Rockwood loam	.10	3	6	14
Rockwood sandy loam	.10	4	7	13
2. Sandy loams				
Dorset sandy loam	0.13	8	8	13
Hubbard sandy loam	.14	8	20	12
Hubbard loamy sand	.10	8	11	11
Marquette sandy loam	.09	4	4	10
Todd sandy loam	.07	5	14	9
3. Light sands				
Arago loamy sand	0.06	4	4	9
Nymore loamy sand	.07	6	13	9
Nymore sandy loam	.06	7	10	8
Kinghurst loamy sand	.06	3	23	8
Cass Lake fine sand	.06	4	13	7
Menahga loamy sand	.06	4	9	6
4. Light sand with heavy subsoil				
Rockwood loamy sand	0.05	3	10	7

PEAT SOILS

About an eighth of the land surface of Hubbard County is occupied by peat, some being found in every township and on almost every section except among the sandy loams south of the central ridge (Fig. 36). The thickness of the peat layer varies from less than a foot to more than 8 feet and in a few places it may exceed 20 feet, but scarcely 200 acres was found with a depth of less than 2 feet. On the small acreage, with a depth of less than 8 inches, the land has been mapped according to the character of the underlying mineral stratum, that which would be brought to the surface by the breaking plow, as either Bluffton loam or Sebeka loamy sand.

In many places, especially in Badoura Township, the peat layer has been burned off within the last few years, either entirely, leaving only the ash, or with occasional hummocks or patches of partly burned peat remaining (Fig. 37). In such cases, as in the case of the very shallow peat, the surveyors have mapped the land according to the mineral substratum exposed. In general, it is safe to assume that the mineral substratum of any tract of peat is similar in texture, sandy or clayey, to the adjacent low-lying mineral soil. Wherever the fire had not reduced the peat layer to an average thickness of less than 8 inches, the land was mapped as peat.

Peat is found in areas that naturally are permanently wet, such as former shallow lakes and ponds and slopes kept wet by seepage water. It consists of the remains of plants that grew and died on the spot, together with a small amount of mineral matter, partly taken up from the water, or from the underlying soil when the peat began to form and

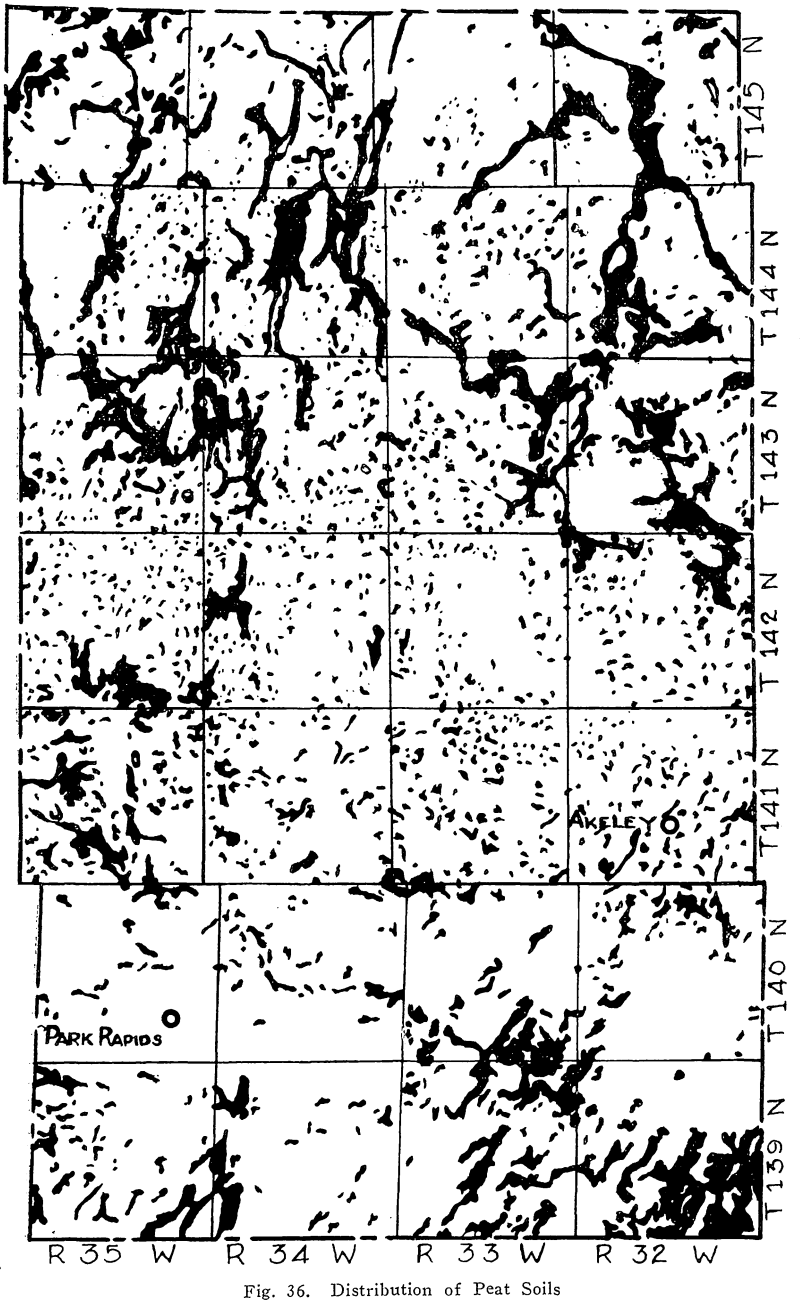

Fig. 36. Distribution of Peat Soils

while it was very shallow, and partly derived from dust blown and mud washed into the bog or lake as the peat was being formed. The character of the vegetation on a bog has usually not remained the same throughout the period of its development, but has altered with changes in the climate and the water level. Accordingly, the present plant cover of a bog does not serve as a reliable indication of the character of the plants that have contributed to the formation of the peat.

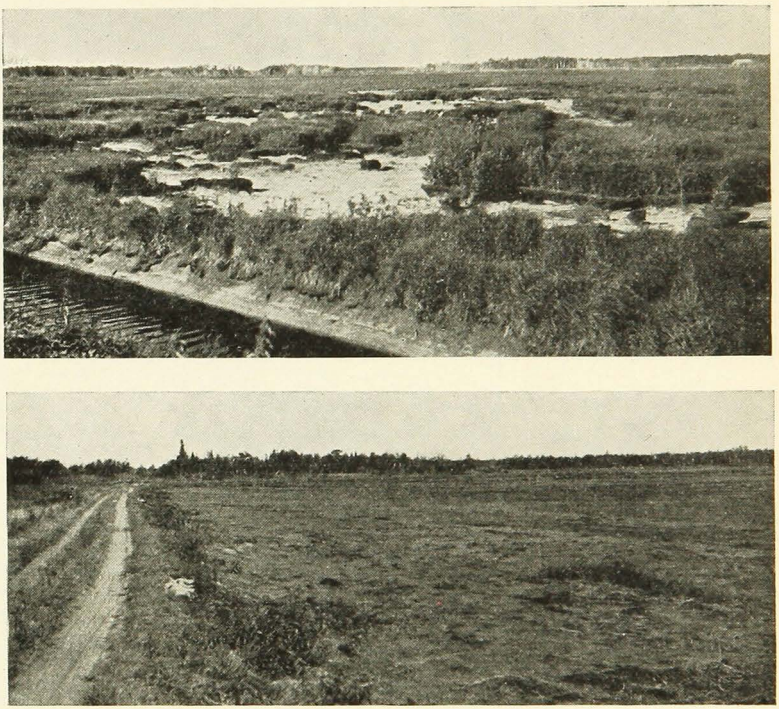

Fig. 37. In the view above recent fires have burned holes in the peat, making the mowing of the wild hay or the preparation of the land for seeding difficult; below, the entire peat layer has been burned off, leaving a bed of ash.

When settlement of Hubbard County began, most of its bogs were occupied by thick stands of tamarack and black spruce, in some places with an admixture of white cedar or balsam fir, below which the ground was covered by a thick mat of sphagnum moss and heath shrubs—leather-leaf, Labrador tea, swamp laurel, Andromeda, cranberries, and blueberries. Here and there were bogs with a ground cover of moss and shrubs like the preceding but without trees or with only a few scattered dwarfed tamaracks or spruce, the typical muskeg. Alder, willow, and small birch trees are now found on some, especially on the margins. The remaining bogs were covered by sedges and wild grasses.

On many of the first kind of bogs fires have killed the trees and destroyed the moss and shrubs and they are now occupied by sedges and grasses, which hide the stumps and fallen tree trunks, thus giving them the appearance of naturally sedge- and grass-covered bogs.

More or less woody material is usually found in the surface foot or two of peat on the bogs occupied by trees, either at present or in the past, in the form of partly decayed stumps, trunks, and branches, mixed with well-decayed, dark brown or black peat, but usually little or no woody material is found in the peat where sedges and grasses or heath shrubs and moss formed the original cover, and it is less decayed and of a lighter brown color.

Table 23

Source and Description of Hubbard County Peat Soils Analyzed

(The analyses are reported in Table 24)

Site	Location		Plant cover at time of sampling	Character of peat
	Township	Section		
A	Rockwood	15	Heath shrubs and sphagnum moss with little or no tree or brush growth	Free of wood
B	Schoolcraft	15	Spruce and tamarack with ground cover of heath shrubs and sphagnum moss	Upper portion somewhat woody
C	Lake George	8	Spruce, tamarack, cedar, birch, aspen, balsam, and alder	Woody
D	Lake George	10	Spruce and tamarack with a few cedar	Free of wood
E	Arago	6	Spruce, tamarack, cedar, birch, aspen, balsam, and alder	Woody
F	Arago	27	Heath shrubs and sphagnum moss with little or no tree or brush growth	Free of wood
G	Todd	2	Spruce and tamarack with a few cedar	Somewhat woody
H	Nevis	36	Open wire-grass bog with but little heath shrub and sphagnum moss and few or no trees	Free of wood with mineral soil admixture
I	Crow Wing	12	Heath shrubs and sphagnum moss with little or no tree or brush growth	Free of wood
J	Crow Wing	15	Spruce, tamarack, cedar, birch, aspen, balsam, and alder	Woody peat
K	Badoura	19	Spruce and tamarack with a few cedar	Woody with silt admixture
L	Badoura	22	Open wire-grass bog with but little heath shrub and sphagnum moss and few or no trees	Free of wood
M	Badoura	33	Open wire-grass bog with but little heath shrub or sphagnum moss and few or no trees	Free of wood
N	Badoura	34	Spruce and tamarack with ground cover of heath shrubs and sphagnum moss	Woody

From 14 representative bogs in different parts of the county, samples of the surface 16 inches of peat were collected for analysis (Tables 23 and 24). Three were open wire-grass bogs; three were open bogs covered by heath shrubs (leather leaf, Labrador tea, and swamp laurel) and sphagnum moss, with only a few dwarfed trees or no trees at all; two were spruce-tamarack bogs with a heath-shrub, sphagnum-moss

Table 24

Chemical Composition and Acidity of Samples of Peat Soil From Hubbard County, Data Arranged in Order of Decreasing Lime Content of Upper Layer

Site	Depth of section, inches	Sample No.	Ash, per cent	Organic matter, per cent	Nitrogen, per cent	Lime, per cent	Active acidity
E	1 to 8	9	15.73	84.27	1.85	5.59	10
E	9 to 16	10	12.33	87.67	2.07	4.46	26
J	1 to 8	19	15.26	84.74	2.45	5.34	22
J	9 to 16	20	16.80	83.20	2.45	5.76	35
G	1 to 8	13	20.31	79.69	2.36	3.96	23
G	9 to 16	14	17.41	82.59	1.92	4.14	25
D	1 to 8	7	10.83	89.17	2.52	3.88	10
D	9 to 16	8	9.44	90.56	2.78	3.80	40
C	1 to 8	5	14.73	85.27	1.80	3.57	37
C	9 to 16	6	18.82	81.18	2.15	3.44	92
N	1 to 8	27	21.79	78.21	2.00	3.56	16
N	9 to 16	28	18.40	81.60	2.29	3.93	16
K	1 to 8	21	41.94	58.06	1.12	2.96	70
K	9 to 16	22	41.36	58.64	0.86	2.52	46
F	1 to 8	11	15.22	84.78	2.93	2.42	31
F	9 to 16	12	11.78	88.22	2.80	2.32	65
M	1 to 8	25	15.66	84.34	3.46	2.36	111
M	9 to 16	26	11.62	88.38	3.51	2.56	99
L	1 to 8	23	16.64	83.36	3.15	2.14	216
L	9 to 16	24	16.41	83.59	3.33	1.84	141
B	1 to 8	3	17.31	82.69	2.21	1.04	736
B	9 to 16	4	19.94	80.06	2.56	0.92	721
H	1 to 8	15	51.51	48.49	2.06	0.99	283
H	9 to 16	16	46.03	53.97	2.38	1.06	252
A	1 to 8	1	13.17	86.83	2.87	0.73	694
A	9 to 16	2	10.04	89.96	2.77	0.77	435
I	1 to 8	17	12.05	87.95	2.58	0.67	1290
I	9 to 16	18	11.01	88.99	2.72	0.94	1110

ground cover but no cedars; three bore spruce, tamarack, and cedars, and the remaining three were like the last but had, in addition, white birch, aspen, and alder. Each was sampled in two sections, the surface eight inches of the solid peat, and the eight inches below this. The former represents the portion that would usually be turned by the plow in preparing a seedbed, and the other, the part just below the depth of ordinary plowing, or the lower part of the furrow slice in very deep plowing. In each sample, determinations were made of ash, organic matter, lime, nitrogen, and acidity. There is no definite relation of the composition of the peat to the character of the present vegetation of the bog or to the presence or absence of woody material in the peat. The ash ranges from 10 per cent at Site D to 51 per cent at Site H; that is to say, if 100 pounds of thoroly dried peat from D were burned, only 10 pounds of ash would remain behind, while from an equal weight of peat from H there would remain 51 pounds of ash. The former would furnish nearly twice as much heat as the latter and leave only a fifth as much ash. The lime content varies from less than 1 per cent to more than 5 per cent. In general, the greater the acidity, the lower is the lime content of the samples, the five sites which show the greatest acidity being represented by the samples with the lowest lime content,

but there are cases where samples with practically the same percentages of lime differ greatly in acidity, as is illustrated in the following:

Site	Sample	Per cent lime	Active acidity
I	17	0.67	1,290
A	1	0.73	694
H	15	0.99	283
B	3	1.04	736
M	25	2.36	111
F	11	2.42	31

When a comparison of the degree of acidity is made with the amount of lime that accompanies 100 parts of organic matter instead of with the percentage of lime, there is no better concordance, as may be seen from Table 25.

Table 25

Relation of Acidity to Lime (CaO) Content in Hubbard County Peats, Sites Arranged in Order of Decreasing Acidity

Site	Active acidity		Lime in dry peat		Lime with 100 pounds of organic matter	
	1 to 8 inch section	9 to 16 inch section	1 to 8 inch section, per cent	9 to 16 inch section, per cent	1 to 8 inch section, pounds	9 to 16 inch section, pounds
I	1,290	1,110	0.67	0.94	0.76	1.06
B	736	721	1.04	0.92	1.26	1.15
A	694	435	0.73	0.77	0.84	0.86
H	283	252	0.99	1.06	2.04	1.96
L	216	141	2.14	1.84	2.57	2.20
M	111	99	2.36	2.56	2.80	2.89
K	70	46	2.96	2.52	6.19	5.18
C	37	92	3.57	3.44	4.18	4.24
F	31	65	2.42	2.32	2.85	2.63
G	23	25	3.96	4.14	4.97	5.01
J	22	35	5.34	5.76	6.35	6.92
N	16	16	3.56	3.93	4.55	4.82
D	10	40	3.88	3.80	4.35	4.19
E	10	26	5.59	4.46	6.63	5.08

At the time of the survey, less than 100 acres of peat had been brought under the plow. The bogs now covered with grasses and sedges—naturally or as the result of fires having destroyed the trees, shrubs, and moss—are used as wild meadows, with here and there a poor pasture. Formerly the open bogs in the eastern part of Badoura Township provided large quantities of the sedges known as wire grass (Carex) and used for the manufacture of grass rugs, but in recent years, as a result of drainage ditches, the sedges have made too poor a growth to justify harvesting. They require a water-logged condition of the peat for satisfactory growth.

Compared with well-drained mineral soils, peat soils suffer from several serious handicaps. Many bogs after being provided with drainage sufficient for ordinary seasons are liable to flooding by exceptionally heavy rains, with the consequent ruin of small grains and cultivated

crops. Many of the tracts of peat in Hubbard County adjoin or partly surround lakes with the surface of the peat so little above the water that drainage is impracticable. Peat soils also are sensitive to overdrainage, and unless the water level is kept sufficiently close to the surface, they fail to give satisfactory yields of most crops in seasons of only average or less than average rainfall, even when the fertilization is adequate.

With but few exceptions, they require annual applications of commercial fertilizers, either phosphate alone, or potash alone, or more commonly both potash and phosphate. The low-lime peats require, in addition, at least an initial application of lime, but most of the peat of Hubbard County, probably at least as much as nine-tenths of its total area, belongs to the high-lime type. Stable manure may be used to supply part of the phosphate and potash, but seldom is it available in sufficient quantity, and, further, it can be used more profitably on mineral soils because nitrogen, its most valuable constituent for these, is seldom needed on peats.

One of the most serious disadvantages is their liability to summer frosts, which may occur at any time of the summer, ruining frost-sensitive crops such as corn, potatoes, beans, and the small grains. These frosts, which are due to the properties of the peat itself and not to its location in depressions, vary much in frequency from bog to bog. Grasses and clovers are practically immune to injury from such frosts and for this reason are the safest crops on peat soils, which when properly managed are especially suitable for use as tame meadows and pastures.

In still another respect, peat soils are at a disadvantage when compared with ordinary or mineral soils. When dry the peat may easily be set on fire accidentally, as from a dropped cigarette or match, the exhaust or ignition of a tractor, or a grass fire, and peat fires, when once well started, are very difficult to extinguish. A single burning may so lower the surface of a drained bog as to make it too wet for cultivation and so make necessary further expense on drainage.

Extensive ditching projects far in advance of reclamation, which were so common in northern Minnesota twenty years ago, were due to the formerly prevailing erroneous belief that drainage alone would make the peat lands productive.

When immediate reclamation is not purposed, the grass-covered bogs had better be left to serve as wild meadows, or, if too wet, drained just enough to allow the cutting of wild hay, while the bogs with merchantable timber should be kept under proper forest management, and all

others left undisturbed until the would-be "developees" have satisfied themselves by systematic investigations and small-scale trials that reclamation is likely to prove profitable.

Muck. While in Minnesota all organic soils are commonly called peat, in the mapping of the soils of Hubbard County the black, more decomposed form has been mapped as *muck*. Usually this contains more mineral matter, or so-called ash, usually from 50 to 80 per cent, most of it consisting of clay, silt, or sand which has been washed in or blown in upon the bog and becomes mixed with the plant remains. The muck layer ranges in thickness from eight inches to two feet. It is found only in some of the small depressions and along some of the streams, occupying in all less than 100 acres. Except on some treeless areas used as wild meadows, it supports a thick growth of alder, willow, and swamp birch, or in some places a dense hardwood growth with a thick stand of underbrush. The methods of handling it are similar to those of the less decomposed material mapped as peat, and its handicaps are much the same except that where it is richest in ash it is much less liable to summer frosts, to injury from fire, and less commonly in need of fertilization or liming.

RELATION OF PRESENT USE OF CROP LAND TO CHARACTER OF THE SOIL

It is of interest to consider to what extent the present farming practices in the county are related to the character of the soils, whether those on the sandy loams differ markedly from those on the heavy soils on one side and from the light sands on the other. For the comparison of the sandy loams with the heavy soils satisfactory data are available. The heavy soils, including Bluffton loam, provide about 25 per cent of the present crop land, the sandy loams 58 per cent, and the light sands 17 per cent, including in the last both Rockwood loamy sand and Sebeka loamy sand. By superimposing upon the soil map the cover map, which accompanies this report, a computation has been made of the acreage of each soil type in crop at the time of the survey, 1929 and 1930. In three adjacent townships largely occupied by heavy soils (Fig. 38), Guthrie, Hart Lake, and Helga, 92 per cent of the crop land was on heavy soils, 6 per cent on light sands, and 2 per cent on sandy loams, while in another group of three townships, Henrietta, Hubbard, and Todd, 91 per cent of the crop land was on sandy loams, 8 per cent on light sands, and less than 1 per cent on heavy soils (Table 26). The first group contained 37 per cent of the crop land of the county on heavy soils and the second 58 per cent of that on sandy loams. Accordingly, we may assume that the farm practices in the first group of town-

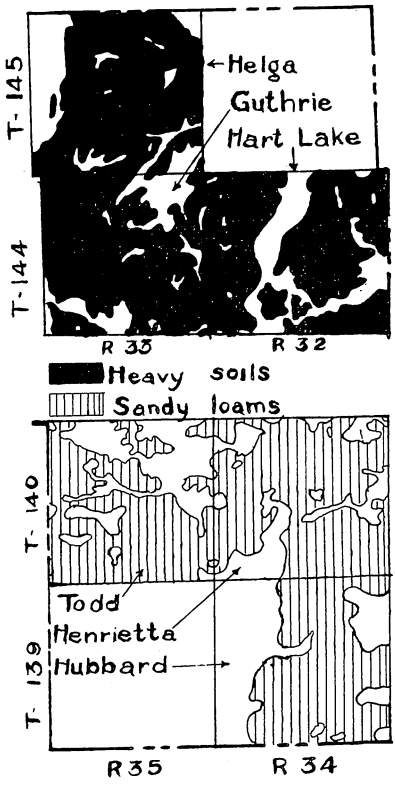

Fig. 38. Distribution of Heavy Soils in a Group of Three Adjacent Townships and of Sandy Loams with Gravelly Subsoil in Another Group of Three Adjacent Townships in Hubbard County

ships are representative of the heavy soils of the county as a whole and those of the second group equally representative of the sandy loams. The records of the State Farm Census and the State Tax Commission provide the data on crops and livestock used in the following discussion.

The leading crops in Hubbard County are tame hay, oats, and corn. During the six-year period, 1928 to 1933, these occupied on the average 80 per cent of the crop land (Table 27). Of this, hay, chiefly timothy and clover-timothy mixture, formed 33 per cent, oats 29, and corn 18. Barley, winter rye, and potatoes each accounted for 5 or 6 per cent of the crop land and wheat for only 3 per cent.

In 1933 there were 193 farms in the three townships with heavy soils, and 198 farms in the three townships with sandy loams (Tables 28 and 29). While the average size of the farms on the sandy loams was scarcely one-third larger, the plow land per farm was nearly four times as great, 127 acres compared with 34, and of this 18 acres was used as pasture on the former but only one acre on the latter. On the sandy loams more than twice the proportion was used for corn but only one-fourth as much for potatoes, two-fifths as much for tame hay crops, one-third for barley, but half as much again for oats. On the sandy loams rye, wheat, and buckwheat together occupied 11 per cent of the total crop acreage, while on the heavy soils rye and buckwheat were not grown and only 1 per cent was devoted to wheat. Cultivated crops occupied 19 per cent of the crop land on the heavy soils and 26 per cent on the sandy loams, small grains 36 per cent on the former and 55 per cent on the latter, while legume hay crops and timothy occupied 42 per cent on the heavy soils but only 17 on the sandy loams.

Table 26

Percentages of Different Soil Types on Improved Farm Land in Three Townships with Heavy Soils Predominating and Three with Sandy Loams Predominating

Soil types	Heavy soil townships				Sandy loam townships			
	Guthrie	Hart Lake	Helga	3 twps.	Hubbard	Henrietta	Todd	3 twps.
	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent
			Heavy soils					
Rockwood sandy loam..	59.76	51.60	32.29		0.00	1.79	0.06	
Rockwood loam.....	19.93	35.56	14.55		0.00	0.00	0.00	
Nebish loam.....	7.00	0.00	40.45		0.00	0.00	0.10	
Beltrami silt loam.....	0.00	0.00	0.00		0.00	0.00	0.00	
Buffton loam.....	7.54	4.26	3.80		0.00	0.12	0.06	
All heavy soils.....	94.23	91.42	91.09	91.97	0.00	1.91	0.22	0.64
			Sandy loams					
Hubbard sandy loam..	0.00	0.00	0.00		51.75	0.17	72.31	
Hubbard loamy sand..	0.00	0.00	0.00		10.50	0.96	0.83	
Dorset sandy loam....	0.00	0.00	0.00		29.20	65.18	3.90	
Todd sandy loam.....	3.36	0.40	0.00		1.66	18.41	11.80	
Marquette sandy loam..	0.69	0.00	1.72		0.00	4.85	1.78	
All sandy loams.....	4.05	0.40	1.72	1.74	93.11	89.57	90.62	91.23
			Sands					
Nymore loamy sand...	0.00	0.00	0.00		1.15	0.00	4.61	
Nymore sandy loam...	0.00	0.00	0.00		2.40	2.72	0.10	
Menahga loamy sand..	0.00	1.74	0.47		2.43	3.86	2.71	
Kinghurst loamy sand..	0.00	0.00	1.10		0.02	0.00	0.80	
Cass Lake fine sand...	0.00	0.00	0.00		0.00	0.00	0.00	
Arago loamy sand.....	0.00	0.00	5.31		0.02	0.41	0.00	
Marquette loamy sand..	0.96	0.00	0.00		0.00	0.10	0.00	
Rockwood loamy sand..	0.59	6.44	0.31		0.00	1.13	0.00	
Sebeka loamy sand....	0.17	0.00	0.00		0.87	0.30	0.94	
All sands.....	1.72	8.18	7.19	6.28	6.89	8.52	9.16	8.13

Table 27

Proportion of Total Land in Crop in Hubbard County During Six-Year Period, 1928-1933, Devoted to Various Crops

	1928	1929	1930	1931	1932	1933	Average
Acres in crop.....	57,300	56,100	61,000	61,000	62,000	59,100	59,417
Per cent of above in:							
Tame hay	34	34	32	29	36	31	33
Oats	27	29	30	29	26	33	29
Corn	15	15	18	21	17	21	18
Potatoes	7	6	5	6	6	4	6
Barley	5	7	6	5	6	4	5
Rye	7	6	6	8	7	4	6
Wheat	5	3	3	2	2	3	3
Small grain crops.....	44	45	45	44	41	44	43
Tame hay	34	34	32	29	36	31	33
Cultivated crops	22	21	23	27	23	25	24

In the number of livestock per farm there was much less difference. There were 7 cows per farm on each, 7 other cattle on the heavy soils and 9 on the sandy loams, 7 sheep and 1 hog on the former, 5 sheep and 4 hogs on the latter. There were 2 horses per farm on the heavy soils but 4 on the sandy loams.

Oats were grown on almost every farm, on 89 per cent of those on heavy soils and 92 per cent of those on sandy loams (Table 30). Corn was more frequently omitted on the heavy soils and potatoes on

the sandy loams. Rye was practically confined to the lighter group and wheat largely so. On the heavy soils barley was raised on about half as many farms as oats and on the sandy loams on about one-quarter as many. There was clover-timothy or timothy meadow on four-fifths of the farms on heavy soils and on half of those on sandy loams. Alfalfa and sweet clover were about twice as common on the latter as on the former. Wild hay was harvested on more than one-quarter of the farms with heavy soil but on scarcely one-thirtieth of those with sandy loam.

Table 28

Use of Farm Land and Numbers of Livestock in Six Townships in 1933

	Townships with heavy soils			Townships with sandy loams			Average for	
	Guthrie	Hart Lake	Helga	Henrietta	Hubbard	Todd	heavy soils	sandy loams
Number of farms	52	73	68	72	74	51	64	67
Acres in farm	123	127	128	162	209	186	126	186
Acres of plow land	30	33	37	94	157	132	34	127
" " corn	4	3	4	19	31	28	4	26
" " potatoes	2	2	4	1	1	3	3	2
" " oats	10	6	9	30	55	47	8	44
" " barley	3	2	4	5	4	1	3	3
" " rye	0*	0	0	4	10	6	0	7
" " wheat	0	0	1	4	5	1	0	3
" " buckwheat	0	0	0	1	3	2	0	2
" " clover timothy hay	10	17	9	5	15	16	12	12
" " alfalfa	1	1	2	5	3	4	1	4
" " sweet clover	0	0	1	5	2	1	0	3
" " other crops for hay	0	1	2	2	6	1	1	3
" " plow land used for pasture	0	1	1	15	20	20	1	18
" " other land used for pasture or idle	86	91	87	74	52	54	88	58
" " wild hay	7	3	4	0	2	2	5	1
Number of cows per farm	9	7	5	6	6	8	7	7
" " other cattle	9	7	6	7	10	11	7	9
" " sheep	8	8	5	4	6	4	7	5
" " hogs	1	1	1	2	3	8	1	4
" " horses	3	2	2	3	4	5	2	4

* Where the amount is less than half an acre it is reported as 0, while for acreages above this the nearest whole number is used.

Table 29

Comparison of Use of Crop Land on Heavy Soils With That on Sandy Loams

Crop	Townships with heavy soils			Townships with sandy loams			Average for	
	Guthrie	Hart Lake	Helga	Henrietta	Hubbard	Todd	heavy soils	sandy loams
	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent
Cultivated crops								
Corn	13	9	11	23	23	26	11	24
Potatoes	7	6	11	1	1	3	8	2
Cereals for grain								
Oats	33	19	25	39	41	42	26	41
Barley	10	6	11	6	3	1	9	3
Rye	0	0	0	5	7	5	0	6
Wheat	0	0	3	5	4	1	1	3
Buckwheat	0	0	0	1	2	2	0	2
Crops for hay								
Clover and timothy	34	54	24	6	11	14	37	10
Alfalfa	3	3	6	6	2	4	4	4
Sweet clover	0	0	3	6	2	1	1	3
Annual crops	0	3	6	2	4	1	3	2

Table 30

Percentage of Total Number of Farms Having Various Crops in 1933

	Townships with heavy soils			Townships with sandy loams			Average for	
	Guthrie	Hart Lake	Helga	Henrietta	Hubbard	Todd	heavy soils	sandy loams
Number of farms.....	52	73	68	72	74	51	64	67
Per cent having:								
Corn	73	78	84	89	97	90	78	92
Potatoes	85	96	100	55	71	78	94	68
Oats	92	82	94	88	93	94	89	92
Barley	52	47	33	38	27	6	44	24
Rye	0	0	3	26	38	24	1	29
Wheat	2	8	18	26	34	14	9	25
Clover-timothy for hay	73	90	76	38	54	61	80	51
Alfalfa.....	15	19	32	50	26	27	22	34
Sweet clover.....	4	4	15	28	19	8	8	18
Other crops for hay..	8	15	16	17	8	3	13	9
Wild hay	38	25	19	0	3	6	28	3

The question may be raised as to whether the distribution of crops on the heavy soil farms would be quite different if these had an acreage of plow land approaching that now found on the sandy loams. A partial answer is provided by Table 31, which gives the crop data for the 10 farms in the three heavy soil townships that had the largest acreages of crop land, this ranging from 80 to 186 acres per farm. In the last three columns the averages for these 10 farms are shown along with those for all 193 farms in the heavy soil townships and 198 in the three with sandy loams. On these 10 farms the use of the crop land resembles that on the 193 farms in the heavy soil townships, without any distinct tendency to be more like that on the sandy loams.

Table 31

Use of Plow Land in 1933 on the 10 Farms Having the Largest Acreages of Crop Land in the Three Townships with Heavy Soils

											Average for		
Farm	A	B	C	D	E	F	G	H	I	J	10 farms A to J	193 farms in heavy soil townships	198 farms in sandy loam townships
Acres in farm	360	320	420	240	320	200	120	280	210	140	261	126	186
Acres of plow land	186	124	121	110	99	86	85	85	83	80	98	34	127
Per cent of plow land in:													
Corn	2	3	8	2	3	17	23	6	9	0	7	11	24
Potatoes	1	23	5	2	9	6	8	1	6	1	6	8	2
Oats	38	16	18	33	24	7	0	0	24	15	18	26	41
Barley	24	11	7	11	0	0	15	0	7	2	8	9	3
Rye	0	0	0	0	0	0	0	0	0	0	0	0	6
Wheat	0	11	0	6	2	0	0	0	0	0	2	1	3
Buckwheat ...	0	0	0	0	0	0	0	0	0	0	0	0	2
Clover-timothy	32	0	62	23	61	70	54	41	54	82	48	37	10
Alfalfa	3	4	0	23	1	0	0	0	0	0	3	4	4
Sweet clover .	0	29	0	0	0	0	0	0	0	0	3	1	3
Other crops for hay ...	0	0	0	0	0	0	0	11	0	0	1	3	2
Pasture	0	3	0	0	0	0	0	41	0	0	4	1	18

Almost no commercial fertilizer or liming material is used in the county. The stable manure is given the same care and used in much the same manner as in the eastern and southern parts of the state. Usually it is applied only to fields to be planted to potatoes or corn. On the heavy soil farms the amount of manure is relatively much more plentiful, the acreage of the cultivated crops being only one-fourth as great while the number of livestock is nearly as great, 17 animal units compared with 21. The beneficial effect upon the crops of the same amount of manure is more marked on the heavy soils than on the dark-colored Hubbard and Dorset soils, partly because the latter are naturally richer in nitrogen and partly because they much more commonly suffer from lack of sufficient moisture to make full use of the nitrogen furnished by the manure. As a result, on the heavy soils manure is prized more highly.

On the better-managed farms on both groups of soils, much the same crop rotation is employed. All available manure is applied to the fields to be planted to potatoes and corn. The following year this land is sown to small grain with a grass mixture, or two crops of small grains may be taken and a grass mixture sown with only the second. A mixture of timothy and red clover is commonly used, but sometimes red clover alone. In recent years sweet clover or alfalfa has often been used in place of common clovers. When a stand of clover and timothy or timothy alone is obtained and it survives until the following spring, the field is used as a meadow for two or three seasons before plowing again. Where sweet clover is sown alone the field can be used as meadow only one season, while where a stand of alfalfa is secured the field is usually kept for hay until the stand has become very thin, which commonly occurs not later than the fifth season. There is little more difficulty in securing a stand of clover and grass on the sandy loams than on the heavy soils, or in keeping it during the early part of the season, but the plants more commonly die before the grain is harvested. Many of the most stony fields on the heavy soils are left in meadow much longer than is customary in the regular rotation, the reduced yields in the later years being considered less serious than the unusual amount of labor required on such land when devoted to cultivated crops or small grains.

For a comparison of the use of the crop land on the light sands there are no satisfactory data. In none of the townships is as much as half the crop land on the sands. Crow Wing, Badoura, Todd, and Straight River townships have the largest acreages, but the highest percentage in any of these is 42, in Crow Wing.

Township	Crop land on sands, acres	Portion of crop land on sands, per cent
Straight River	2,020	23
Todd	1,340	12
Crow Wing	1,220	42
Badoura	990	30

Corn appears to be the most extensive crop on the sands, with oats in second and winter rye in third place, while barley and wheat are seldom sown, and there is little clover or timothy. On a few farms there is alfalfa, which even without the use of sulfur fertilizers has been found the most productive hay crop. The farmers who have only a sand soil depend for roughage upon wild hay, corn stover, corn fodder, and straw. While some of the tenant farmers on the sands fail to make use of their limited supply of manure, the owner farmers make as good use of it as those on the more productive soils, applying it on the fields to be planted to potatoes and what remains on the corn. Clovers and timothy are much less commonly sown with small grains than on the sandy loams, failure to secure a stand is much more common, and even when a stand results the yield of hay is usually very much lower. Most of the few farmers who recognize the great superiority of alfalfa on the sands have been deterred from sowing much of it because of the relatively high cost of the seed.

SOIL MANAGEMENT AND CROP ADAPTATION

In efforts to increase the productivity of any Hubbard County farm, the character of its soils should first of all be considered, because the measures necessary to secure the highest returns on one soil type may be without effect on another and frequently two or three very different soils are found on the same farm. In considering the management of the various soil types and their suitability for different crops, it will be convenient to use the same grouping as in Table 10 (p. 42), the members of each group having much in common.

In this discussion advantage is taken of the results of experiments conducted by the University of Minnesota on experimental fields representing four of these groups, namely: well-drained heavy soils, light sands, sandy loams with gravelly subsoil, and peat soils. Experiments have been conducted for five seasons, 1930 to 1934, on Nebish loam on fields on the north side of the Hubbard-Beltrami line, opposite section 3 in Helga Township. The sand experimental fields, located on Nymore loamy sand, one mile west of Bemidji, have been operated for the last 12 years. From 1924 to 1930 experiments with alfalfa and the clovers were carried out near Park Rapids on a field of Hubbard sandy loam, which had been homesteaded in 1882 and had later changed

hands many times. Little or no manure had been applied, and seldom if ever had clover been grown. The differences in texture of soil and subsoil on the first three experimental fields and the differences in their ability to retain moisture and so withstand drouth may be seen from Figure 39, in which are shown the moisture equivalents of five soil profiles on each. These profiles resemble those of the Nebish loam, Hubbard sandy loam, and Nymore loamy sand illustrated in Figures 33 and 34. The peat experimental fields are farther removed from Hubbard County, one at Golden Valley in eastern Marshall County, one near Karlstad in Kittson County, one at Fens in St. Louis County, one at Coon Creek in Anoka County, one at Milaca in Mille Lacs County, and a sixth at Page in the same county. The last has a low-lime peat soil, while the others are of the high-lime type.

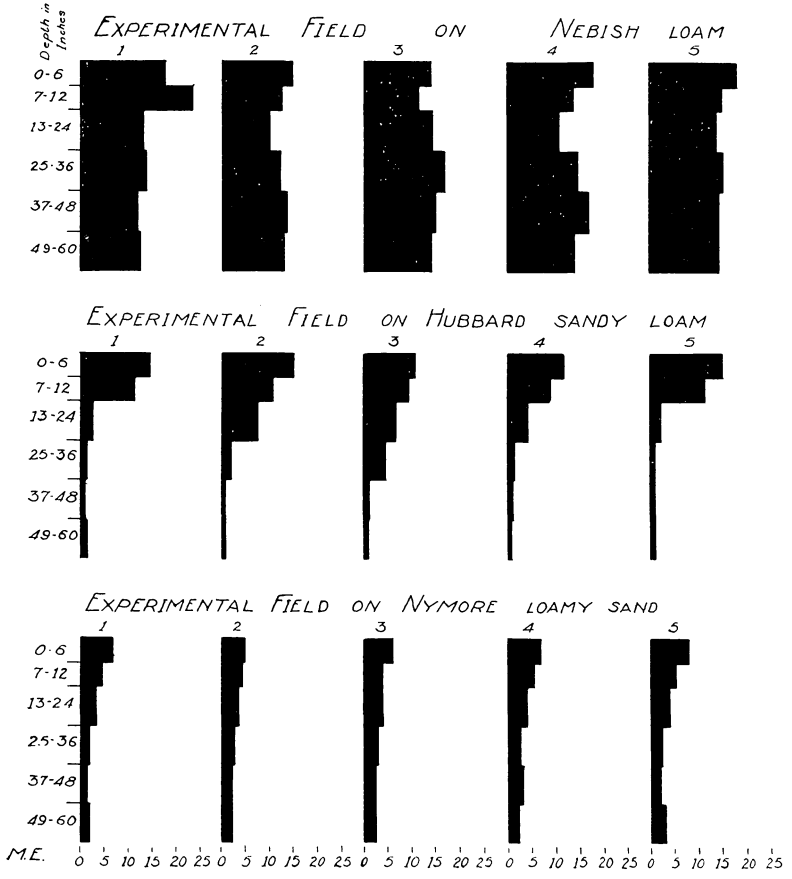

Fig. 39. Moisture Equivalents of Five Typical Profiles on Each of Three Experimental Fields of the University of Minnesota

No. 1 on Hubbard-Beltrami County line; No. 2 near Park Rapids; No. 3 near Bemidji, four miles from No. 1.

Mineral Soils

Medium and heavy loam soils. The soils of this group are well adapted to the various small grains grown in the county (Table 27), alfalfa, sweet clover, the common clovers, and grasses. In the case of corn, they give heavier yields of silage and fodder than the lighter soils but because of their much greater water-retaining capacity they warm up more slowly in the spring, necessitating later planting, and also mature the grain more slowly, with the result that they are less suited to the production of ear corn. For potatoes also they are well adapted, except in scattered small areas of Beltrami silt loam and Nebish loam with surface soil of exceptionally fine texture.

If reasonable precautions are observed, little difficulty is experienced in getting stands of alfalfa sown with spring grains and carrying it through even the driest summers. Sweet clover is more likely to succumb to unfavorable conditions, and the young plants of red and alsike clovers are still more likely to die during prolonged periods of hot, dry weather preceding the harvesting of the grain.

In the case of crops other than the legumes,[5] the outstanding requirement is nitrogen, which is supplied by stable manure, by the excrement of animals on pastures, by the roots, stubble and fallen leaves of all crops, and especially by those of legumes—the only crops able to collect from the air their needed supply of nitrogen. Accordingly, the nitrogen requirements of these soils can be met by growing sufficient alfalfa or clover, feeding the hay on the farm, and returning the nitrogen to the fields in the form of manure. The heavier the yield of the legume hays and the better the care taken of the manure the smaller will be the acreage of legumes needed to supply the nitrogen required for satisfactory yields of the other crops.

Alfalfa and the clovers require an especially large amount of sulfur. Where it is deficient, the most economical method of supplying it is to apply either gypsum or sulfur flour in the spring. The sulfur problem is dealt with at length in another section of this report as it is not limited to the heavy soils of the county (see p. 107).

Nothing of a preventive nature can be done regarding the stone problem, which is important on the Rockwood and Nebish soils of this group, except to reduce as far as possible the loss of soil by erosion from the plow land, as the washing away of the soil lowers the surface and exposes stones that were originally below the reach of the plow. Many fields that have been stumped and more or less freed of boulders and the larger cobblestones should have been left uncleared, or if cleared before their extreme stoniness was recognized, they should have

[5] The legume crops grown in Hubbard County include the clovers, alfalfa, peas, and beans.

been left as pastures without any attempt to remove the stone. Where there are many boulders in a heavy soil that has a heavy subsoil, the land is well suited to grass and may provide about as much pasturage as tho the stones were absent.

Sandy loams with gravelly subsoils. In seasons of normal rainfall and temperature conditions these sandy loams, because of their earliness, are superior to the heavy soils for the production of ear corn, and to the light sands because of their better surface soil. For other crops, with the possible exception of red clover seed, they are less productive than the heavy soils, especially in the drier seasons, owing to their drouthy subsoils and not to a poorer natural supply of plant food. The dark-colored soils respond less to nitrogen fertilizers than the heavy soils and so far have shown no need of sulfur fertilizers, while the light-colored soils may be expected to respond to both nitrogen and sulfur, much as do the heavy soils. Their supply of potash, however, is somewhat poorer, and on fields that have been longest under cultivation without manuring potash fertilizer shows a marked benefit. Phosphate fertilizers have so far shown little or no effect. The lime supply is poorer, on the whole, on some fields of Hubbard and Todd soils liming being necessary for alfalfa and sweet clover but not for the common clovers and other farm crops.

Satisfactory stands of clover or alfalfa may be counted upon if the seed is sown without a nurse crop on a moist, firm seedbed, also if sown with spring grains on an equally good seedbed and the weather continues favorable until the grain is harvested. During the critical period, from the germination of the seed until the grain crop is harvested, alfalfa withstands dry weather somewhat better than sweet clover, and the latter, in turn, better than the common clovers. Where, however, there is insufficient lime in the surface soil, sweet clover succumbs first and common clovers last. These soils are not well adapted to alfalfa production, being inferior not only to the heavy soils but even to the better types of light sands, such as the Nymore soils, because for this crop the lower subsoil of the latter, consisting of sand, is much superior to the gravelly lower subsoil of these sandy loams. Only in seasons of unusually heavy or well-distributed rainfall are satisfactory yields of legume hays obtained (Table 32). While on the better types of light sand the yields of alfalfa increase with the age of the stand, that has not been found true on these sandy loams. For this reason sweet clover is relatively more promising as a hay crop on these soils. For meadow and pasture grasses these soils are much superior to the light sands altho inferior to the heavy soils. To reduce their drouthiness or to increase their water-holding capacity, there is little or nothing that can be done. To

lessen the competition for moisture from the soil, the control of weeds is important and somewhat thinner planting of crops is advisable.

As on the heavy soils, all stable manure produced on the farm should be properly cared for and used to the best advantage and a sufficient acreage of legume hay crops grown in a suitable rotation, trying a sulfur fertilizer on these. Where lime is deficient, marl or ground limestone should be applied well in advance of seeding any considerable acreage of alfalfa or sweet clover.

Table 32

Yields of Legume Hay Crops on Experimental Field on Hubbard Sandy Loam Near Park Rapids. All Plots Had Been Limed and Given Sulfur, Potash, and Phosphate Fertilizers

Season	Rainfall*					Total for 5 months	Yield per acre		
	April	May	June	July	Aug.		Alfalfa	Sweet clover	Medium red clover
	inches	inches	inches	inches	inches	inches	tons	tons	tons
1925.....	2.4	1.7	7.2	2.2	3.7	17.2	2.04	1.40	....
1926.....	0.1	1.7	2.0	1.4	3.2	8.4	1.06	1.04	0.44
1927.....	1.9	3.1	2.4	2.5	1.7	11.6	0.94	0.86	0.56
1928.....	1.4	0.6	3.4	4.6	7.1	17.1	1.54	1.32	0.89
1929.....	0.9	1.4	0.5	1.4	2.2	6.4	0.37	....	....
1930.....	0.7	4.0	2.9	1.4	2.3	11.3	0.58	0.55	....
1932.....	2.4	4.6	3.6	1.9	3.7	16.2	1.68	....	....
Average for 3 years, 1926 to 1928.....							1.18	1.07	0.63
Average for 5 years, 1925 to 1928 and 1930.....							1.12	1.03	....
Average for 7 years, 1925 to 1930 and 1932.....							1.17	....	....

* By comparison with Table 1 it may be seen how the rainfall compares with that of previous years. The averages at Park Rapids for 44 years (Table 1) are: April, 1.9 inches; May, 2.9; June, 4.3; July, 3.6; August, 3.4; total for 5 months, 16.1.

Light sandy soils. Marquette loamy sand and Arago loamy sand are practically excluded from consideration as farm land, the former because of its extreme stoniness and the latter because of its roughness, but for garden patches their productivity may be increased by the same methods as are recommended below for the more tillable sands. While all the soils of this group are drouthy and to be regarded as of low grade for agriculture, the other members in most places are capable of a remarkable increase in productivity without any corresponding increase in labor or outlay of money. For certain crops the possible increase in yield is so great that parts of these soils now in plowland may well be continued as such, especially where included in farms mainly on heavier soil or where they can be operated in conjunction with such farms.

The low water-retaining capacity of the surface soil makes necessary the use of much more skill and thought in order to secure satisfactory stands of alfalfa or clover than is required in the case of the sandy loams or the heavy soils, while the low water-retaining capacity of both upper subsoil and surface soil causes lighter yields of the non-

legume crops, even where plant nutrients are liberally supplied. The supply of nitrogen in these soils when first plowed is very low and under cropping declines very rapidly. In addition, it is much more difficult to maintain nitrogen in fair amount, by means of manuring and rotation with legume crops, than is the case with the sandy loams and heavier soils. For alfalfa, the lower subsoil of most of these sands is distinctly superior to that of the group of sandy loams, permitting a much deeper penetration of the roots, so that the crop, after the first or second season, is able to use practically all the water from rain and snow. For this reason the growing of alfalfa, combined with the use of a sulfur fertilizer on it where needed, should receive first consideration in the farming of the light sands already in crop land (see p. 107). In some places the lower subsoil of Menahga loamy sand is almost as gravelly as that of the sandy loam group, and in such cases there is no prospect of reasonable success with alfalfa.

What may be called the "traditional system" of farming these light soils has been to clear the land of stumps, mostly of jack and Norway pine, break it, and plant potatoes and corn for a year or two. Then, usually, oats are grown for a year or two, while corn and potatoes are planted on newer land. All available manure is usually applied to the land to be devoted to these cultivated crops, especially where there is no new breaking on which to plant them. Red clover is frequently sown with the oats, but usually no stand remains when the grain is harvested, the clover plants having succumbed in the competition for moisture. If the clover survives until harvest, it ordinarily goes into winter in fair condition and, provided a normal amount of snow falls and remains through the winter, usually shows a fair stand about the end of April, when growth starts. If the rainfall of April, May, and June is favorable a fair yield of hay is obtained, unless the sulfur supply is very deficient, but if the rainfall of these months is light the yield will be very low. So in order to secure one fair crop of clover hay the sand farmer, no matter how skilled he may be, requires two successive seasons with very favorable rainfall and a moderately favorable winter between, a combination that is not experienced frequently. The result has been that the supply of legume hay has been very low and only at irregular intervals have there been clover residues, stubble and roots, to be plowed under to increase the small supply of nitrogen in the soil. The manure produced on the farm was small in amount because of the scarcity of hay and straw, and its nitrogen content was low because of the usual lack of legumes. As a consequence, the nitrogen shortage grew more acute year by year and the crop yields fell lower and lower. Where timothy was sown along with the clover and a stand secured, a timothy

meadow might be maintained for some years after the clover had died out, but even with a full stand of timothy in seasons of favorable rainfall the yields of hay have been low, as illustrated in Table 33.

Table 33

Comparison of Yields of Hay From Different Legumes and Grasses on Bemidji Sand Experimental Fields. Sulfur Fertilizer Applied for Crops After 1924

	Rainfall of crop season—April May, June, July, and August	Yield per acre						
		Alfalfa*	Sweet clover	Medium red clover	Mammoth red clover	Alsike clover	Timothy	Brome grass
	inches	tons	tons	tons	tons	tons	tons	tons
1923	12.4	0.81	0.86	0.46	0.42	0.44	....	0.40
1924	11.5	1.18	1.15	0.41	0.55	0.55	0.25	0.34
1925	17.7	2.67	1.43	2.54	....	2.21	....	0.26
1926	10.7	2.16	1.47	1.31	1.54	1.00	0.31	0.32
1927	14.6	2.55	1.10	1.27	2.37	1.94	0.93	0.71
1928	14.7	1.77	0.85	0.75	1.19	1.15	0.53	0.33
1929	8.7	1.09	1.08	0.16	0.18	0.12	0.15	0.34
1930	10.2	1.07	1.23	0.88	0.81	0.96	0.40	0.37
1931	12.5	2.41	1.06	1.03	0.98	....	....	0.41
1932	13.3	2.21	2.14	....	....	....	....	....
1933	10.7	1.34	....	....	....	....	....	....
1934	11.8	1.59	1.54	1.30	....	....	....	....
Av. for 6 years, 1924 and 1926 to 1930	11.7	1.64	1.10	0.80	1.08	0.93	0.43	0.40
Av. for 8 years, 1923 to 1930	12.6	1.66	1.11	0.97	1.20†	1.05	....	0.38
Av. for 9 years, 1923 to 1931	12.6	1.75	1.10	0.98	1.18†	....	....	0.39
Av. for 11 years, 1923 to 1932 and 1934	11.3	1.78	1.23	....	....	....	....	....
Av. for 12 years	11.3	1.77	....	....	....	....	....	....

* Yields of alfalfa reported for 1923 to 1930 are from a field seeded in 1922 while those for 1931 to 1934 are the averages from other fields, with 2- 3- and 4-year-old stands.

† In computing this average it has been assumed that the yield of mammoth clover in 1925 would have been the same as that of medium red—2.54 tons.

In contrast with the above is a system well tried out on the Bemidji Sand Experimental Fields, which are on Nymore loamy sand and are similar in texture of surface soil and subsoil, in nitrogen supply, and in acidity to the Nymore soils mapped in Hubbard County. In this im-

Fig. 40. Corn is a favorite crop on Nymore loamy sand, a soil type better adapted to alfalfa.

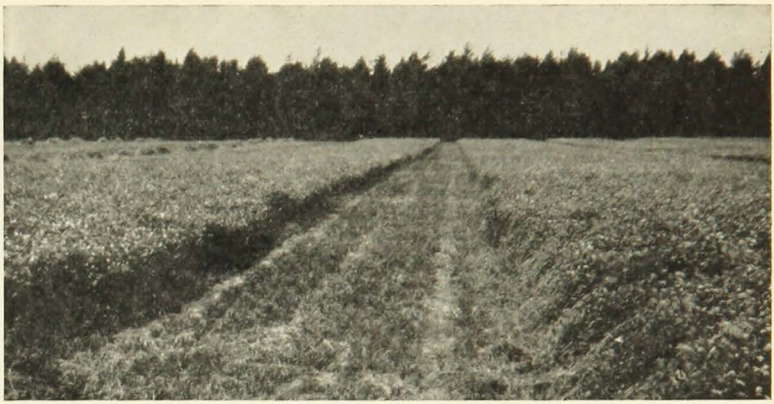

Fig. 41. First Cutting of Alfalfa on Nymore Loamy Sand (Bemidji Sand Experimental Field) in 1925, A Season With Favorable Rainfall
A sulfur fertilizer had been applied. Jack pine grove in background.

proved system alfalfa is made the main crop and left until it winter-kills or becomes choked with grass, using sulfur fertilizer whenever needed (Figs. 40 and 41). It gives both the highest yield and the best quality of hay and increases the yields of following non-legume crops more than do the clovers. Sweet clover may be used to provide pasture and even part of the hay. All or most of the hay should be fed on the farm and the manure used on only non-legume crops where these do not directly follow alfalfa. Dairy farming is almost obligatory. Cash crops are best limited to winter rye, at times with alfalfa hay and possibly alfalfa seed, and usually only enough potatoes grown for the family's use. The winter rye, which is the small grain best adapted to these light soils, will provide bedding for the stock and in addition grain to sell or feed. As it is usually difficult to secure a stand of alfalfa or sweet clover when seeded on winter rye, one of the spring grains should be used as nurse crop and of these oats are the most productive. Less skill is required to secure stands of alfalfa and sweet clover when sown alone, but satisfactory stands result also, even in very dry seasons, when both grain and legumes are sown on the same day, provided the seedbed is both moist and very firm.

The superiority of alfalfa to the other legumes as well as the poor yields of grasses is shown by Table 33, giving yields of hay on the Bemidji Sand Experimental Fields. The plots from which the data are taken were seeded without a nurse crop, but entirely satisfactory stands of alfalfa have been secured during each of the last eight years by seeding it with oats in April or early May with the seedbed both moist and very firm. Sweet clover and the common clovers seeded at the same time and in the same manner have not done so well. The sweet clover

has frequently been much thinner, while the common clovers usually have died out largely before harvest. Sweet clover has yielded about as much hay as alfalfa sown at the same time, but the latter with increasing age, up to three or four years, commonly gives higher yields, due to the increasing depth to which its roots penetrate in the sandy subsoil. As a result, the average yield of alfalfa is about half as high again as that of sweet clover (Table 33).

Commercial nitrogen fertilizers greatly increase the yields of grains on these sands but not more so than do the alfalfa residues (Table 34). However, the second and later non-legume crops following alfalfa show steadily and rapidly declining yields. Cultivated crops cause a greater fall in productivity than the small grains, and wet summers, with accompanying higher crop yields, a greater fall than dry summers. So a desirable rotation becomes one in which alfalfa occupies a field for three to eight years, to be followed by one year of cultivated crops, rye, or oats and then oats seeded with alfalfa, or two or three years of non-legume crops with manure on the earlier ones before reseeding to alfalfa. The latter has the advantage of better maintaining the supply of sulfur, potash, and phosphate.

Fertilization with sulfur nearly doubled the yield of alfalfa but usually had less effect on the clovers (Table 35). On the grain and grass crops it had no effect except where these followed legumes, in which case the better growth of legume on the sulfur-treated plot was followed by a higher yield of grain or grass.

The yields of grains immediately following alfalfa, while two or three times as high as on adjacent sand which had neither been in a legume crop nor recently manured nor given a commercial nitrogen fertilizer, have been only about two-thirds as high as on near-by heavy soil in a good state of fertility (Table 36). The sands approach the heavy soils in productivity most nearly when older stands of alfalfa are compared.

Where fields of these light sands form part of farms mainly on heavy soil, or are operated in connection with such farms, it will be more profitable to devote them almost exclusively to alfalfa, leaving the seedings as long as there is a fair stand, then plowing and planting corn, to be followed by alfalfa sown either with a spring grain or sown alone. None of the manure from the farm should be applied to the alfalfa or first crop of grain following it, unless there should be an unusually small acreage of other crops, as the manure will give more profitable returns on the latter, applying to the alfalfa only gypsum. Even if either potash or phosphate or both should become sufficiently reduced, it will usually be more economical to furnish these to the alfalfa in the form of commercial fertilizers.

Table 34

Yields of Small Grain Crops on Bemidji Sand Experimental Fields, Showing Effect of Alfalfa Residues Compared With That of a Nitrogen Fertilizer, 200 Pounds Per Acre of Sodium Nitrate or Ammonium Sulfate. The Unfertilized Plots Had Neither been in a Legume Crop Nor Received Manure in Recent Years

Season	Rainfall			Winter rye			Oats			Barley		
	May	June	July	No fertilizer	Nitrogen fertilizer	First crop after alfalfa	No fertilizer	Nitrogen fertilizer	First crop after alfalfa	No fertilizer	Nitrogen fertilizer	First crop after alfalfa
	in.	in.	in.	bu.	bu.	bu.	bu.	bu.	bu.	bu.	bu.	bu.
1927	5.3	5.2	2.7	12	30	..	13	33	..	..	..	..
1928	0.5	3.1	3.8	19	39	..	20	44	44	..	..	45
1929	0.9	1.6	3.1	15	28	..	13	24	..	9	14	..
1930	3.4	2.8	2.2	12	26	..	10	25	31	..	..	24
1931	1.8	4.6	3.3	14	26	27	17	39	44	9	18	32
1932	3.8	3.4	2.4	11	30	36	12	38	50	5	12	29
1933	3.8	2.1	0.8	7	15	16	7	12	13	1	1	1
1934	1.6	5.9	1.1	10	18	20	18	30	40	8	..	17
Average 1931-1934				11	22	25	13	30	37	6	..	20
Average 1927-1934				11	26	..	14	31	..	..	..	..

Table 35

Effect of Sulfur Upon the Yields of Legume Hay on the Bemidji Sand Experimental Fields. The Alfalfa Was Continuously on the Same Land, Being Sown in 1922 and Surviving Through 1930, While the Other Legumes Were Not Harvested From the Same Land Oftener Than Every Other Year

Season	Yield per acre without sulfur	Yield per acre with sulfur	Increase from sulfur application	
	tons	tons	tons	per cent
		Alfalfa		
1923	0.81	1.09	0.28	35
1924	1.18	1.99	0.81	69
1925	1.67	2.67	1.00	60
1926	0.84	2.16	1.32	157
1927	1.19	2.55	1.36	114
1928	0.66	1.77	1.11	168
1929	0.39	1.09	0.70	179
1930	0.59	1.07	0.48	81
Average	0.92	1.80	0.88	96
		Sweet Clover		
1925	0.76	1.43	0.67	88
1926	1.32	1.47	0.15	11
1928	0.82	0.85	0.03	4
1930	0.95	1.23	0.28	29
Average	0.96	1.24	0.28	29
		Medium Red Clover		
1925	0.75	2.54	1.79	238
1926	0.90	1.31	0.41	46
1927	1.08	1.27	0.19	18
1928	0.58	0.75	0.17	29
1930	0.74	0.88	0.14	19
Average	0.81	1.35	0.54	66
		Mammoth Red Clover		
1926	1.07	1.54	0.47	44
1927	1.75	2.37	0.62	35
1928	1.13	1.19	0.06	5
1930	0.66	0.81	0.15	23
Average	1.15	1.48	0.33	29
		Alsike Clover		
1925	0.95	2.21	1.26	133
1926	0.93	1.00	0.07	8
1927	1.75	1.94	0.19	11
1928	1.08	1.15	0.07	7
1930	0.81	0.96	0.15	18
Average	1.10	1.45	0.35	32

Table 36

Yields of Various Crops on Nymore Loamy Sand and Nebish Loam on Experimental Fields Near Bemidji. Grain Crops on Nebish Loam Only in High State of Fertility But on Loamy Sand Both on Run-down Soil and as First Crop After Alfalfa

Season	Oats			Barley			Corn			Alfalfa	
	Light sand		Nebish loam	Light sand		Nebish loam	Light sand		Nebish loam	Light sand	Nebish loam
	Run-down	After alfalfa		Run-down	After alfalfa		Run-down	After alfalfa			
	bu.	bu.	bu.	bu.	bu.	bu.	bu.	bu.	bu.	tons	tons
1930	10	31	68	..	24	45	10	27	..	..	..
1931	17	44	62	9	31	34	6	11	36	2.4	2.7
1932	12	50	57	5	29	37	11	24	36	2.2	2.7
1933	7	7	28	1	1	13	15	26	25	1.2	2.2
1934	18	40	52	8	17	44		13	19	1.1	1.4
Average	13	34	53	6*	19	32	11†	20†	32†	1.7	2.2

* Average for 1931 to 1934.
† Average for 1931, 1932, and 1933 only.

Rockwood loamy sand. As Rockwood loamy sand occurs in many scattered small tracts, usually adjacent to larger bodies of heavy soils, and in but few places forms more than a minor part of a farm, it may well be managed as suggested in the preceding paragraph.

Poorly drained mineral soils. Unless provided with good artificial drainage Bluffton and Sebeka soils are ordinarily too wet for cultivated crops, small grains, or legume crops, thus limiting their use to grasses for hay and pasture. Where moisture conditions permit plowing and preparation of a seedbed, reed canary grass may prove the most profitable grass for hay, especially where the original coating of organic matter has not been burned off, but this grass is more sensitive to a lack of plant food than the wild grasses. Where good artificial drainage has been established, Bluffton loam is adapted to the same crops as the members of the group of heavy soils and Sebeka loamy sand to the same as the light sands, and in seasons of only average or less than average rainfall they may be expected to give higher yields than the corresponding soils that have good natural drainage. It is better to confine alfalfa to naturally well-drained fields.

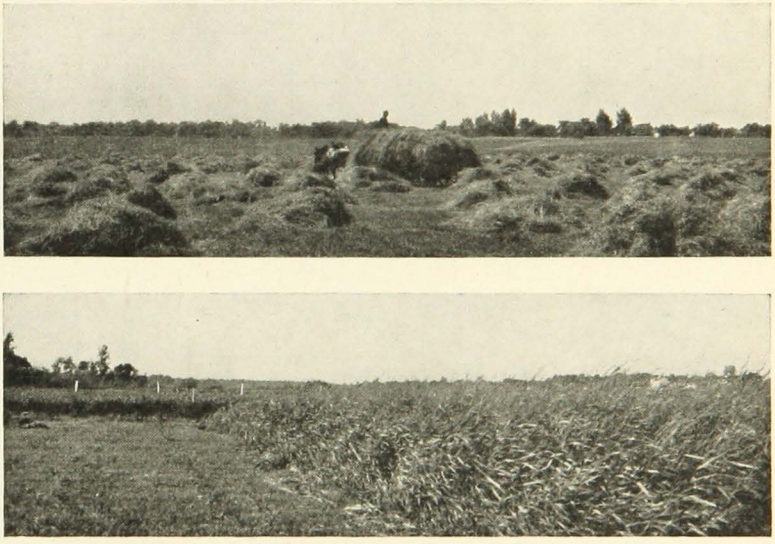

Fig. 42. Meadows on Coon Creek Peat Experimental Fields, a High-lime Peat Fertilized With Phosphate and Potash
Above, timothy-clover July 17, 1924; below, reed canary grass on a wet area, June 15, 1932.

Peat Soils

Crops. In considering the suitability of peat soils for various crops it is assumed that the land will be properly fertilized and that where it is of the low-lime type it has been limed. Of the general farm crops hay is the most promising, using a mixture of timothy with red or alsike clover (Fig. 42). Excellent pastures of Kentucky bluegrass with white clover may be maintained where the land is not overdrained

(Fig. 43). Where it is subject to flooding, or the water table is very close to the surface through much of the year, a trial of reed canary grass is to be recommended, but this grass is as dependent as other crops upon proper fertilization (Fig. 43). Were it not for the danger of summer frosts most of the crops grown on the mineral soils of Hubbard County, with the exception of alfalfa, might successfully be grown on the peat. In Hubbard County the frequency of summer frosts on the peat may be expected to make potato growing too hazardous. Corn, buckwheat, and vegetables sensitive to frost also must be excluded. Of the small grains winter rye is the most reliable, with oats and barley next. Wheat usually does poorly, being especially subject to rust. Flax is less in need of fertilization than most other crops but is very sensitive to summer frosts and commonly fails on burned peat the first year after burning. Carrots, turnips, celery, lettuce, and cabbage do especially

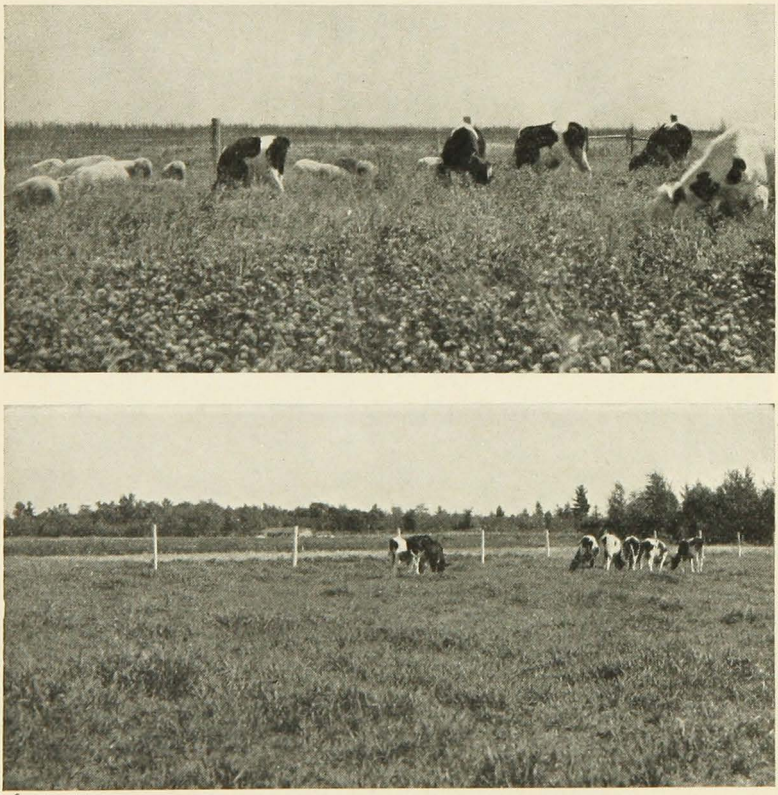

Fig. 43. Pastures on Peat Experimental Fields

Above, cows and sheep at Fens on clover, timothy, and bluegrass, a high-lime peat fertilized with phosphate and potash, July 15, 1920; below, cattle at Page on reed canary grass, a low-lime peat limed and fertilized with phosphate and potash, July 24, 1931.

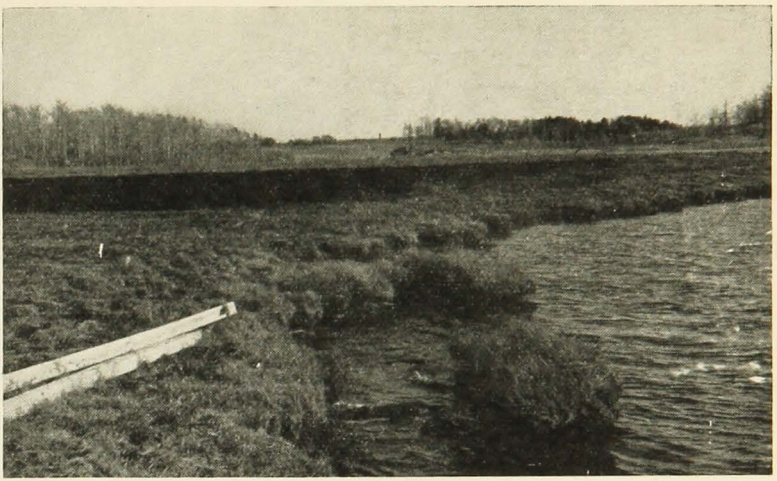

Fig. 44. Peat Beside a Lake, Too Wet for Other Crops, Being Prepared in 1933 to Seed Reed Canary Grass

A good stand was secured, but only on the parts fertilized with phosphate and potash has the growth been satisfactory.

well, but the market for these is limited and there are very extensive undeveloped tracts of peat nearer the large markets, more than 103,000 acres in Anoka County and 50,000 acres in Hennepin County.

Fertilization. Most peat soils require an application of both phosphate and potash fertilizers, but extensive areas in the most northwesterly counties of the state require only phosphate for some years after being brought into cultivation. A few bogs need only potash, and occasionally one is found that needs no fertilization during the first year or two. On high-lime peats the supply of readily available nitrogen seems likely to last as long as the peat, and the only place where nitrogen fertilizers may be expected to find a profitable place is with certain truck crops, such as lettuce, celery, and onions. Farm manure, which furnishes nitrogen, phosphate, and potash may be employed to fertilize peat soils, but usually it can be used more profitably on mineral soils, where its content of nitrogen is especially valuable and where the organic matter which it supplies is usually of distinct benefit.

Liming. Liming high-lime peat is not beneficial and at times even lowers the crop yields, but low-lime bogs must be given a dressing of two or three tons per acre of ground limestone, or its equivalent in the form of marl. This should be well worked in with a disk in advance of seeding. Later applications of about one ton per acre once in three to five years may be found necessary. Because of the expense it would have entailed, it was not feasible to analyze samples from all

the bogs of the county in order that the low-lime and high-lime bogs might be differentiated on the soil map. Whenever definite information is needed as to the lime supply of a peat bog, the owner should take samples of the surface 8 to 10 inches of the solid portion, which in many of the Hubbard County bogs underlies a loose surface mat of shrubs and moss, and send these to the Division of Soils, University Farm, St. Paul.

Burning. Burning the peat sets free a considerable amount of phosphate and a smaller amount of potash, thus providing a fertilization, especially where only phosphate is deficient. Burning the surface layer of peat is desirable in some cases but should be practiced only after a careful consideration of the local conditions and taking extreme precautions to prevent the escape of fire. Burning may ruin the drainage system, leave a boulder field, or, in the case of shallow peats, leave too little organic matter for a good seedbed. In the first season after burning the crop yields are usually excellent, except of flax, but unless the peat layer is shallow and underlain by a good mineral soil the beneficial effect will rapidly become less and may even be practically gone at the end of the first season.

Where an accidental burning has made clearing operations easy, the land should be cleared and put into some crop before wild vegetation has occupied the surface. A clover-grass mixture is one of the most suitable crops for this purpose. Where the peat layer has been removed by fire, the underlying soil, if a loam or clay, may be farmed by the ordinary methods used on mineral soils.

Water control. On mineral soils with a fine-textured subsoil the water table may be lowered without fear of overdrainage, but on peat soils, especially with meadows and pastures, the water table is often so lowered that crops suffer from drouth. Where experiments have been conducted in a climate like that of Minnesota, the heaviest yields have been obtained where the water was not more than from 20 to 40 inches below the surface. For small grains and cultivated crops about 40 inches is in general considered the best level. Most hay crops make their best growth when the water table is about 20 inches below the surface, but for pasture it must usually be kept lower, at about 30 inches, as otherwise the surface will not be firm enough to support the weight of the cattle. For reed canary grass the water should be close to the surface through most of the growing season, and occasional flooding is very beneficial. While much higher returns can be obtained where the water level can be regulated, in most places in Hubbard County satisfactory control appears out of the question, as when the crops are most in need of water there is usually none to hold back.

One of the most important factors in favor of drained peat soils with a controllable water level is that when in hot dry summers the hay on the surrounding mineral soils is light and the pasture short these peats may be expected to produce their heaviest yields.

Rolling. The use of a very heavy roller is one of the most important operations on peat lands, especially on meadows and pastures. The roller makes the surface firmer, permitting the use of heavier machinery, lessens the breaking through of cattle and horses, and improves the moisture supply by increasing the upward movement of water. The roller should exact a pressure of not less than 1,600 pounds per yard of length. It may be of solid concrete, or an iron shell filled with concrete, 30 inches in diameter. For use with a team, a length of four feet is satisfactory, the weight of this being about 3,500 pounds. The proper time for rolling is when the peat is moderately moist, as when either too dry or too wet the compression is only temporary. When the soil is in the proper moisture condition for rolling, the impress of a heavy footprint will remain distinct for some time. On meadows and pastures the first rolling should be in the spring soon after the grass and clover have begun to grow, and the last should be in the fall at the end of the pasture season. An additional rolling, after the first crop of hay on meadows and about the middle of the summer on pastures, has been found to increase the yields. For reed canary grass meadows, rolling is not recommended.

THE SULFUR PROBLEM IN HUBBARD COUNTY

Sulfur is an essential nutrient for all crops, some requiring very much more than others, but in most places enough sulfur compounds are brought down from the air by rain and snow, or settle as dust, to meet fully all crop requirements, independent of what may be secured from the soil. In some districts, however, the amount so furnished is not enough for those crops that need the most, such as alfalfa, and when in such places the soil, also, is able to supply but little there arises the sulfur problem. Hubbard County has this problem, but, rather than an outlay of much money for fertilizers, it requires thoughtful consideration, small-scale trials and continued careful observation (Fig. 45).

Of the ordinary field crops grown in Hubbard County, alfalfa and the clovers are the richest in sulfur, and alfalfa is usually the first crop to suffer from a lack of this nutrient element. It also is the most convenient one to use in trials to decide whether a sulfur fertilizer is needed. If the alfalfa needs none it is unlikely that any of the other crops do. While rape, rutabagas, turnips, and cabbages are still richer

in sulfur, these crops are usually grown on manured land and manure furnishes more or less sulfur.

The amount of sulfur removed in a crop depends not only upon how much is needed for its growth but also upon how much is available, because if much is present in the soil plants take up much more than they need. Thus at the Bemidji Sand Experimental Fields a ton of the alfalfa hay from land where no sulfur had been applied contained 3.4 pounds of sulfur, but it contained 5.1 pounds from land where 10 pounds of sulfur per acre had been applied, and 6.8 pounds from land where 40 pounds had been applied. Hay from parts of the state where sulfur is not deficient is richer in this constituent than that from sulfur-

Fig. 45. Effect of Sulfur Fertilizer on Alfalfa
Bundles were harvested from equal areas, the larger in each case from the fertilized part of the field. Left, on Nymore loamy sand, June, 1925; right, on Nebish loam, July, 1928.

deficient fields. Thus in 1924 the hay from the second cutting of alfalfa at seven experimental fields of the University of Minnesota showed the following amounts of sulfur per ton of hay:

Bemidji, 1.7 pounds; Backus, 2.4 pounds; Coon Creek (Anoka County), 5.8 pounds; Aspelund (Goodhue County), 5.5 pounds; Kenyon, 5.8 pounds; Caledonia, 5.0 pounds; Hayfield, 7.8 pounds. None of these hay samples was from plots that had recently been manured or ever been given a sulfur fertilizer. Only at Bemidji and Backus have sulfur fertilizers increased the yields, at the latter less than at Bemidji.

The only known sulfur-deficient area in Minnesota is in the northern counties. It may be considered to center in Beltrami County, stretching northward to the Canadian border and southward to near the Hubbard-Wadena county line. How far it extends westward and eastward is not known, but probably not more than 30 or 40 miles. Within this

area most of the fields of alfalfa on which a sulfur fertilizer has been tried have shown more or less increase in yield, except in the case of the dark-colored sandy loams with drouthy subsoils.

Near Bemidji, the amount of sulfur brought down in rain, snow, and dust has been determined for several years and found to be exceptionally low, equivalent to only about four pounds per acre annually. It is probable that throughout this sulfur-deficient area the amount is about the same. The quantity that falls on an acre in the course of a season is not proportional to the precipitation but appears as large in a dry season as in a wet one.

The soils with poor natural drainage, Bluffton loam and Sebeka loamy sand as well as the peat, muck, and alluvial soils, are usually well supplied with sulfur, while those naturally well drained are not. In well-drained soils the sulfur is present chiefly in the form of gypsum, or calcium sulfate, except what is in the organic matter of the surface soil, and as the latter decomposes its sulfur content passes chiefly into gypsum. Gypsum is somewhat soluble in water, and as a result water percolating downward through the soil dissolves part of the gypsum and carries it down to the water table, from which it escapes to the streams and lakes.

In wet seasons there is most likely to be need of a sulfur fertilizer, as then there is water enough for heavy crop yields and also the greatest opportunity for the sulfur in the soil, in the form of gypsum, to be leached out. In dry seasons, the lighter crops will require less sulfur and there will be less loss in the drainage.

It may be assumed that a crop of two tons per acre of alfalfa from a field naturally well supplied with, or fertilized with, sulfur will contain at least 10 pounds of sulfur, while a 30-bushel crop of oats or corn will remove only about 5 pounds per acre and about half of this in the straw or stover will be returned to the fields in the manure. When the grain also is fed, practically all the sulfur removed in the crop will be returned to the fields and as a consequence the following crop will need only a small amount from the air. On the contrary, alfalfa, which requires a large amount of sulfur whenever the rainfall is sufficient to produce good yields, usually receives no return from the barnyard, the manure being used on other fields. So the longer alfalfa remains on a field and the heavier the yield of hay, the greater will be the danger of sulfur becoming deficient. As the clovers are usually harvested from a field only once in several years, they do not have the same opportunity to exhaust the sulfur.

Sulfur for use as a fertilizer may be purchased either as gypsum, commonly called land plaster, or as sulfur flour. Gypsum contains ap-

proximately 19 per cent of sulfur and costs from $15 to $18 per ton in car lots delivered at Park Rapids or Bemidji, while sulfur flour is practically pure sulfur and costs about $2.50 per 100-pound sack, but much less when purchased in large quantities. As 100 pounds of it furnishes as much sulfur as 500 pounds of gypsum, it is really the more economical form to use, but without a special spreader it is rather disagreeable and difficult to apply, while gypsum is very easy to apply. Gypsum has no disagreeable features, and it shows its effects upon the crops somewhat sooner than sulfur does. No matter which is later to be used on a field scale, gypsum is much to be preferred in the first trials on a farm.

No simple rule can be laid down as to just where, when, and how much of a sulfur fertilizer should be applied. One field may need it for alfalfa, while the surrounding fields do not, because of differences in previous cropping and manuring. It may show little or no benefit during the first year or two after alfalfa is sown and then, as illustrated in Table 35, it may cause a great increase in yield every year until the legume winter-kills. The rainfall furnishes sufficient sulfur for the young legume plants during the year of seeding, and an addition of sulfur will not assist in securing a stand. Fall applications are as effective as spring applications, but if the legume should winter-kill the fields will ordinarily be used for crops that will not be benefited by the sulfur. So, in general, it is most profitable to apply sulfur fertilizers in the spring of the first crop season, that is, the year after the alfalfa or clover has been sown, but they may be applied at any time without fear of injuring the crops.

It usually is unwise to purchase sulfur fertilizer to use on a field scale before, from small-scale trials, it has been found beneficial. For these, gypsum, at the rate of 400 pounds per acre, may be scattered by hand on plots as small as a fortieth of an acre, that is, 11 paces by 11 paces. There should preferably be several such in a field, or the application may be made on two or three narrow strips, three to eight feet wide, crossing the entire field. No larger acreage should be treated until the crop on these plots or strips can be seen standing out distinctly greener, taller, and thicker than on the unfertilized land. Then the whole field may at once be given 100 to 300 pounds per acre of gypsum, or a fifth as much sulfur flour, including in this application the trial plots or strips, so that these now have much more sulfur. On a clover or old alfalfa field the lighter rate of application is preferable for the field as a whole, but not for the trial strips, while on a young alfalfa field, that is, one in its first or second crop year, the heavier rate is to be recommended. No further application should be made until the

treated plots or strips again stand out distinctly with a much better growth and darker color than the surrounding crop. Then is the time for a second application. For at least several years and without further expense or effort on the part of the farmer, the trial plots or strips will continue to provide a warning as to the need of later sulfur applications.

If the alfalfa and clovers on a farm receive enough sulfur, no attention need be paid to the sulfur needs of the other crops, if the land is liberally manured for any rape, rutabagas, turnips, cabbages, and onions that may be grown. On most farms the increased amount of sulfur in the fertilized alfalfa and clovers will be transferred to the other fields in the stable manure and the droppings of the animals on pasture, and so the sulfur supply of the soil will gradually be built up to a point where no further application of sulfur fertilizer will be necessary for maximum yields.

V. PRIMARY LAND USE IN HUBBARD COUNTY

Information was obtained with regard to the use actually made of the land and the use which the owner apparently had in mind for it. To attempt to interview each owner was out of the question, but information was gathered from persons in the community who were in a position to know. Township assessors were relied upon and one or more others were selected because of their knowledge of the locality, as a check on the information supplied by the assessors. Personal inspection was made where it seemed necessary.

Table 38
Land in Agricultural Use, by Townships

Township	Owner-operated	Tenant-operated	Non-resident tenant	Meadow land	Pasture land	Idle farm land	Abandoned farm land
	acres	acres	acres	acres	acres	acres	acres
Akeley	7,217.17	1,180.50	2,156.22	40.00	49.35	97.45	971.53
Arago	4,165.97	786.35	886.19	.....	440.00	.....	1,193.16
Badoura	4,952.71	1,023.88	1,694.44	7,280.00	.....	.....	520.00
Clay	487.41	.....	795.86	.....	1,285.35	.....	811.20
Clover	2,484.26	.....	1,395.75	.....	.....	.....	629.00
Crow Wing Lake	4,591.88	520.00	1,479.16	100.00	275.00	120.00	1,518.51
Farden	7,440.81	488.37	1,935.39	.....	160.00	200.00	1,105.27
Fern	6,536.56	240.00	1,564.88	21.25	.....	.....	123.75
Guthrie	7,593.76	798.22	2,148.86	.....	.....	.....	360.00
Hart Lake	8,135.10	889.21	3,356.81	64.10	.....	.....	220.00
Helga	7,856.41	1,476.00	2,084.15	.....	.....	.....	155.41
Hendrickson	3,315.52	360.00	760.00	120.00	67.87	.....	560.00
Henrietta	7,668.51	3,976.66	3,527.28	185.38	.....	4.00	745.91
Hubbard	8,173.10	4,500.39	4,367.01	309.80	79.00	188.80	460.00
Lake Alice	886.09	120.00	685.80	.....	.....	.....	153.75
Lake Emma	3,054.30	372.25	935.49	.....	.....	.....	557.05
Lake George	2,881.60	384.53	360.00	311.75	40.00	.....	767.06
Lake Hattie	3,933.33	560.00	664.65	.....	.....	.....	369.00
Lakeport	5,828.31	525.25	927.93	39.00	.....	200.00	916.10
Mantrap	4,743.45	340.00	2,912.11	251.86	.....	.....	1,060.05
Nevis	6,033.83	1,292.17	1,516.54	.....	118.35	25.00	744.50
Rockwood	4,703.51	551.93	1,394.04	.....	.....	.....	344.50
Schoolcraft	2,156.20	120.00	896.25	.....	.....	.....	409.45
Straight River	9,468.89	2,260.00	4,528.07	20.00	.....	80.00	520.00
Todd	7,081.20	4,955.40	3,857.08	154.55	100.36	160.00	179.67
Thorpe	1,612.25	.....	575.87	.....	.....	.....	920.00
White Oak	7,855.39	1,874.73	3,847.85	.....	40.00	120.00	1,338.50
Steamboat River District	327.23	.....	96.50	.....	.....	.....	.....
Total, county	141,184.75	29,595.84	51,350.18	8,897.69	2,655.28	1,195.25	17,613.37

Tables 38, 39, 40, and 41 indicate the land use for the county by townships. Devoted to agriculture were 252,492 acres, or 42 per cent of the area of the county, including some idle and vacant farm land as well as land being used for farming at the time the survey was made. Forestry use accounted for 322,451 acres, or 54 per cent of the total

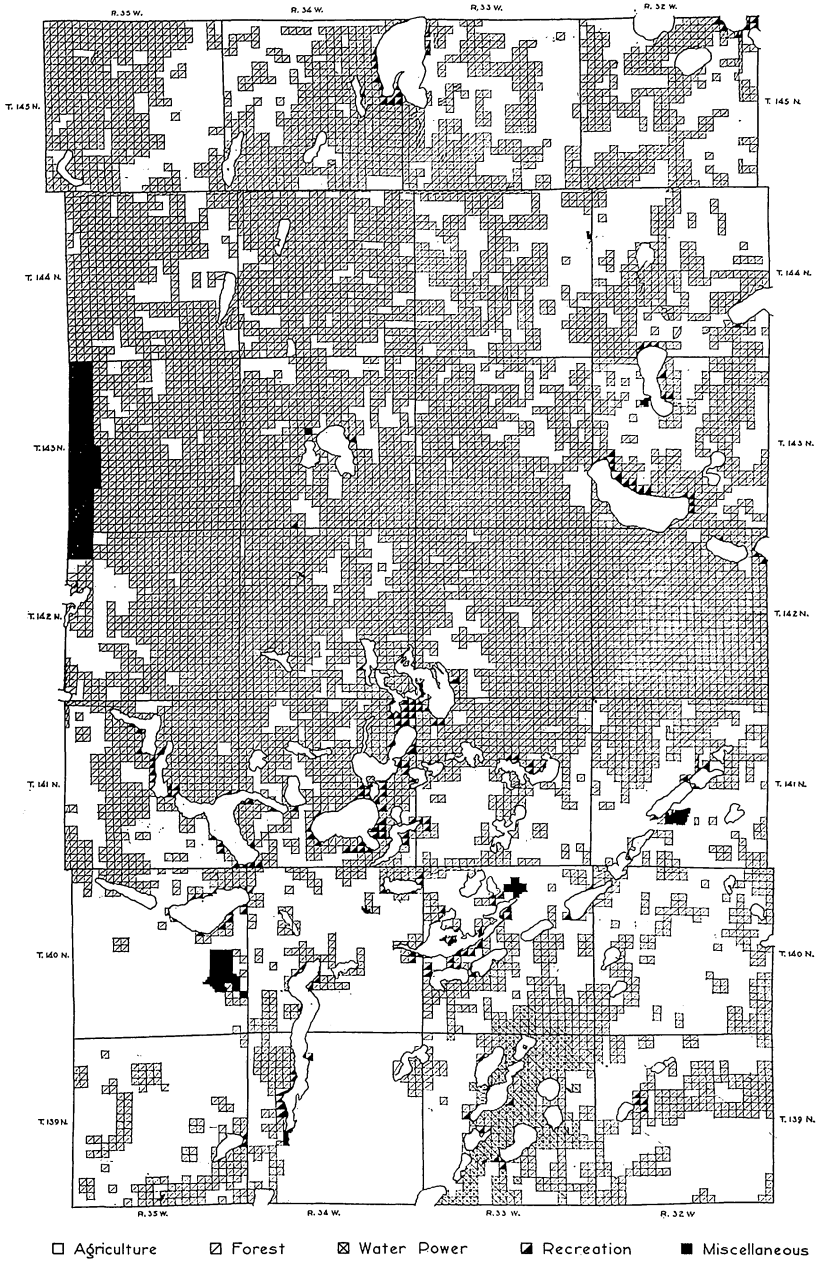

Fig. 46. Land Use in Hubbard County, January 1930

area; water power, 7,151 acres, or 1.2 per cent; recreation (including commercial, non-commercial, and farm resorts) and state park, 12,017 acres, or 2.01 per cent; residential and industrial uses, 1,825 acres, or 0.31 per cent, and 683 acres, or 0.11 per cent, were used for miscellaneous purposes. Figure 46 shows land use in Hubbard County.

Table 39

Land in Forest and Water-power Use

Township	Timber	Potential timber	Abandoned or residual timber	Water-power
	acres	acres	acres	acres
Akeley	.....	.....	9,358.58	.....
Arago	160.00	500.50	11,389.31	.....
Badoura	160.00	680.00	6,342.17	.....
Clay	.....	11.20	18,423.07	.....
Clover	.....	.....	16,816.56	.....
Crow Wing Lake	235.45	636.45	3,704.71	5,973.79
Farden	2,125.01	560.00	7,248.11	76.03
Fern	160.00	.....	13,678.34	.....
Guthrie	.....	.....	11,635.98	.....
Hart Lake	.....	164.06	8,565.81	.....
Helga	80.00	.....	9,659.08	.....
Hendrickson	.....	.....	17,721.58	.....
Henrietta	6.25	.....	4,172.90	.....
Hubbard	84.56	832.89	2,175.78	.....
Lake Alice	.....	556.70	16,252.67	.....
Lake Emma	52.75	117.50	10,437.85	.....
Lake George	64.25	453.34	16,239.85	.....
Lake Hattie	.....	25.77	15,687.54	.....
Lakeport	238.37	200.00	9,908.40	.....
Mantrap	.....	.....	10,072.45	.....
Nevis	.....	40.00	6,889.17	859.35
Rockwood	426.75	.....	13,492.61	.....
Schoolcraft	80.00	1,440.00	16,785.15	.....
Straight River	40.00	320.00	5,003.36	.....
Todd	160.00	305.02	2,292.35	242.03
Thorpe	40.00	14.02	18,899.05	.....
White Oak	.....	160.00	6,720.49	.....
Steamboat River District	.....	722.05	21,025.32	.....
Total, county	4,113.69	7,739.50	310,598.24	7,151.20

Table 40

Land in Resort, Industrial, and Other Uses

Township	Resorts			State Park	Private summer homes	Industrial and residential		Railroad, school, etc.
	Commercial	Farm	Non-commercial			In villages	Outside villages	
	acres	acres	acres	acres	acres	acres	acres	acres
Akeley	123.65	26.15	0.25	.....	76.60	457.23	.....	87.06
Arago	402.05	121.55	.....	.....	89.90	.....	.....	2.05
Badoura	.....	.....	.....	.....	157.40	.....	1.00	7.20
Clay	12.15	.....	.....	.....	95.45	.....	3.00	3.00
Clover	49.50	.....	.....	499.24	.....	.....	.....	.....
Crow Wing Lake	192.85	80.38	.....	.....	33.78	.....	.....	.12
Farden	54.41	82.99	.....	.....	45.13	.....	.....	83.61
Fern	.....	15.25	.....	.....	.....	.....	.....	2.00
Guthrie	.....	.....	.....	.....	.....	35.00	2.00	15.81
Hart Lake	69.20	32.25	.....	.....	78.30	.....	.....	46.92
Helga	.....	.....	.....	.....	101.45	34.00	16.96	69.24
Hendrickson	.....	.....	.....	.....	.....	.....	.....	.....
Henrietta	274.57	.....	10.00	.....	308.79	24.16	.....	58.90
Hubbard	28.08	.....	.....	.....	304.19	27.08	.....	.....
Lake Alice	.....	.....	.....	3,305.09	.....	.....	.....	11.00
Lake Emma	901.63	.....	.....	.....	1,239.31	.....	.....	4.50
Lake George	91.00	.....	.....	.....	1.00	.....	18.30	40.00
Lake Hattie	.....	.....	.....	.....	.....	.....	.....	1.00
Lakeport	303.87	79.11	.....	.....	170.52	55.67	14.62	65.45
Mantrap	137.80	217.95	.....	.....	277.16	.....	.....	15.83
Nevis	11.95	.....	.....	.....	721.76	259.38	2.00	55.92
Rockwood	220.35	.....	.....	.....	122.37	.....	.....	1.00
Schoolcraft	.....	.....	.....	.....	.....	.....	.....	.....
Straight River	.....	.....	.....	.....	73.96	9.00	.....	82.12
Todd	28.00	26.45	114.64	.....	189.42	860.82	4.50	9.20
Thorpe	58.41	.....	.....	.....	104.75	.....	.....	.....
White Oak	.....	.....	.....	.....	50.65	.....	.25	3.50
Steamboat River District	17.50	38.00	.....	.....	149.01	.....	.....	17.11
Total, county	2,976.97	720.08	124.89	3,804.33	4,390.90	1,762.34	62.63	682.54

Table 41

Percentage of Area in Different Uses

Township	In farms	Forest and related use	Water-power	Resorts and summer homes	Industrial and residential	Miscellaneous
Akeley	49.17	47.30	....	1.04	2.09	0.40
Arago	37.10	59.84	....	3.05	....	0.01
Badoura	67.81	31.47	....	0.69	....	0.03
Clay	15.41	84.07	....	0.50	0.01	0.01
Clover	20.61	76.88	....	2.51	....	....
Crow Wing Lake	44.20	23.53	30.70	1.57	....	....
Farden	52.44	45.98	0.35	0.84	....	0.39
Fern	37.98	61.94	....	0.07	....	0.01
Guthrie	48.25	51.51	....	....	0.17	0.07
Hart Lake	58.57	40.38	....	0.83	....	0.22
Helga	53.74	45.23	....	0.47	0.24	0.32
Hendrickson	22.63	77.37	....	....	....	....
Henrietta	76.84	19.94	....	2.82	0.12	0.28
Hubbard	83.97	14.37	....	1.53	0.13	....
Lake Alice	8.40	76.50	....	15.04	....	0.06
Lake Emma	27.83	60.03	....	12.11	....	0.03
Lake George	21.91	77.39	....	0.42	0.09	0.19
Lake Hattie	25.83	73.98	....	....	0.19	....
Lakeport	43.32	53.13	....	2.85	0.36	0.34
Mantrap	46.47	50.29	....	3.16	....	0.08
Nevis	52.39	37.32	4.63	3.95	1.41	0.30
Rockwood	32.91	65.48	....	1.61	....	....
Schoolcraft	16.37	83.63	....	....	....	....
Straight River	75.33	23.94	....	0.33	0.04	0.37
Todd	79.57	13.30	1.17	1.74	4.18	0.04
Thorpe	13.98	85.28	....	0.74	....	....
White Oak	68.50	31.26	....	0.23	....	0.01
Steamboat River District	1.89	97.11	....	0.92	....	0.08
Average for county	42.17	54.21	1.20	2.01	0.31	0.11

LAND IN AGRICULTURAL USE

The land employed in agriculture or intended for such use was divided into seven classes, namely; (1) owner-operated, (2) resident-tenant, (3) nonresident-tenant, (4) meadow, (5) pasture, (6) idle, and (7) abandoned farm land.[1] More than one-half (56 per cent) of the total land in agricultural use was owner-operated, while about 12 per cent was operated by resident tenants, and 20 per cent by nonresident tenants. Meadow land constituted 3½ per cent, pasture land 1 per cent, idle land about ½ per cent, and abandoned land between 6 and 7 per cent. The high proportion of land operated by nonresident tenants may be a result of land abandonment as far as owner operation is concerned. In many cases, the buildings are vacant but the land is rented and operated. Some of this land is being farmed indifferently and may be on the way to definite abandonment. Some nonresident tenants may be operating the land as a means of increasing the size of their farm units.

[1] The distinction made between (6) and (7) is that land classed as "idle" while included in farms has not been used and has no apparent farm use, while abandoned land has been used for agricultural purposes at some time.

There is wide range in agricultural use of land in different parts of the county. In Hubbard Township 84 per cent of the area is in farm use, while in Steamboat River less than 2 per cent is so used. The following grouping of townships may be made: 15 townships have more than 40 per cent of their area in farms; 3 have 30 to 40 per cent; 5 have 20 to 30 per cent; 3 have 10 to 20 per cent, and 2 have less than 10 per cent.

The 15 leading agricultural townships are found in two compact groups. Ten[2] of them form a solid block in the southern part of the county. The other five[3] are in the northeastern corner. Of the three townships having from 30 to 40 per cent of their area in farms, two adjoin the northeastern group and one the southern group. The region low in agricultural use is the central and northwestern part of the county.

As already noted, farm land referred to as "abandoned" is land that shows evidence of once having been in farm use but which is no longer thus employed. The townships in which more than 4 per cent of the agricultural area fell in this class were Crow Wing, White Oak, Arago, Farden, Mantrap, Lakeport, Thorpe, and Nevis. While the exact reasons for abandonment have not been determined for the areas concerned, it is reasonable to assume that abandonment takes place primarily on the land which has been found submarginal in agricultural use. First settlers do not necessarily select the most productive land. Because of the need for an income as early as possible, the land that offers the least resistance to development frequently is chosen first. This is true of southern Hubbard County, and of the early settlement of prairies, in general. With the exception of natural prairies, land that is easily subdued may turn out to be the least productive. The fact that it supports only a meager growth of vegetation under natural conditions suggests its lack of productivity for agricultural purposes. As might be expected, a large proportion of the abandoned land has a relatively poor soil. Accessibility of the land also is an important factor in its agricultural use.

Farm land is abandoned because it does not yield returns justifying its continued use in agriculture. Several striking examples of reversion to the original state were found in the county. In Badoura Township, a piece of land that was a cultivated field 30 years ago now has a stand of jack pine. A similar illustration, somewhat less advanced, was found in Lake George Township. Many fields that had formerly been cul-

[2] Hubbard, Todd, Henrietta, Straight River, White Oak, Badoura, Nevis, Akeley, Mantrap, Crow Wing.

[3] Hart Lake, Helga, Farden, Guthrie, Lakeport.

tivated were now patchy meadows with scattering jack pine, but few, if any, such cases were found on heavy productive soils.

There is a distinction between abandoned farm buildings and abandoned land. The number of deserted buildings far outnumbered the abandoned land subdivisions. Many of the deserted buildings had been homesteaders' cabins, built and occupied while proving claims. Some of these homesteads were taken because of the timber on the land, and abandonment of such homesites is not an illustration of agricultural failure. However, many of the abandoned buildings, weathered and dilapidated, are evidence of such failure. They are impressive arguments for land policies that will reduce their number to a minimum. In considering this phase of land development, the loss caused by such failures, both to the individuals directly involved and to society, must not be overlooked.

All abandonment of buildings has not occurred on submarginal land. In some cases it represents merely the consolidation of farms, the land continuing in agricultural use. Such abandonment is a natural part of any movement towards larger farm units.

In connection with the abandonment of farm buildings, it may be noted that temporarily, at least, many such structures are now occupied by persons who in this period of economic stress have adopted this means of subsistence with a minimum of cash outlay.

LAND IN FOREST USE

Figure 47 shows "intent of ownership" in land for forest use. Land dedicated to timber use includes three classes: (1) merchantable timber, (2) young timber, and (3) cut-over or residual timber. In this class, as in the case of agricultural use, the entire area of a subdivision was included in a type if that type was considered sufficiently important in that subdivision to influence intent of ownership in the opinion of the men supplying the information.

As previously indicated, 54 per cent of the area of the county was included in this classification. Steamboat River, with 97 per cent of its area, had the largest proportion of its land in forest use. Todd Township had the smallest, 13 per cent. Nine townships in the central part of the county had more than 15,000 acres each of such land. The townships with the lowest amounts naturally are those in the southern and northeastern parts of the county, where agriculture is developed most extensively.

A relatively insignificant proportion of the forest land is in merchantable timber. Less than one per cent of the county area was

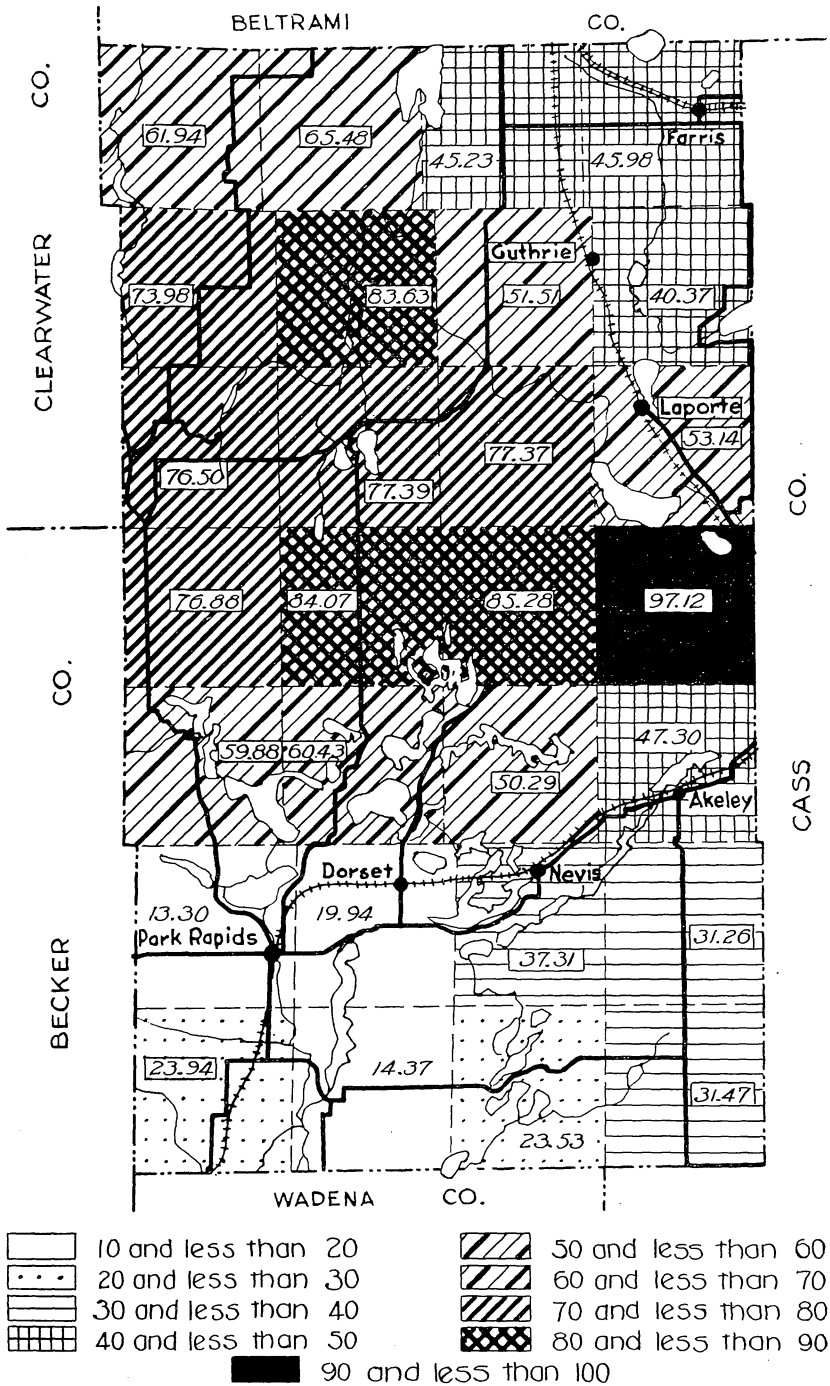

Fig. 47. Land in Forest Use in Percentage of Total Area of Townships, as Indicated by Intent of Ownership

placed in this class. Young growing timber[4] altho somewhat greater, likewise was relatively unimportant, being a little more than one per cent. The residual or cut-over timber lands constitute the principal part of the land in forest use. This class includes land which grew merchantable timber at one time but which now has been cut or burned over, leaving a residue of no immediate merchantable value.

The ownership of the cut-over land remains largely in the hands of the original purchasers who bought the land for the timber which grew on it. Some of it is owned by land companies or others who bought it with the intent of reselling to settlers. The land included in this general class varies widely in actual or potential value. Some of it may eventually be cleared for agricultural use. Much of it will restock itself to timber, will be replanted, or will remain residual or cut-over.

Sixteen of the 28 townships in the county have over 50 per cent of their area in cut-over land. These are found in a wide belt extending across the middle and to the northwestern part of the county.

Figure 48 shows the percentage of township areas in forest use as indicated by the planimeter readings according to the cover survey. The actual percentages in such areas are materially higher than those indicated by intent of ownership. Figure 49 shows percentage of total area of township in actual farm use according to the cover survey. These percentages are materially smaller than those indicated by intent of ownership. Figure 50 shows percentage of township areas plowable according to the cover survey.

WATER POWER

There were 7,151 acres owned for water-power purposes. Crow Wing Township includes nearly 6,000 acres. Nevis, Todd, and Farden townships, with smaller areas, have the rest.

RECREATIONAL

Land use for recreational purposes was divided into five main classes: (1) commercial resort, (2) farm resort, (3) non-commercial resort, (4) private summer home, and (5) state park. Commercial resorts include those operated as a main source of financial gain, ranging from summer hotels to individual cottages. Farm resorts are those operated as a sideline in conjunction with a farm. Noncommercial resorts include golf courses and land surrounding farmers' club halls.

About 3,000 acres of land are included in commercial resorts, scat-

[4] Roughly, between six and nine inches in diameter.

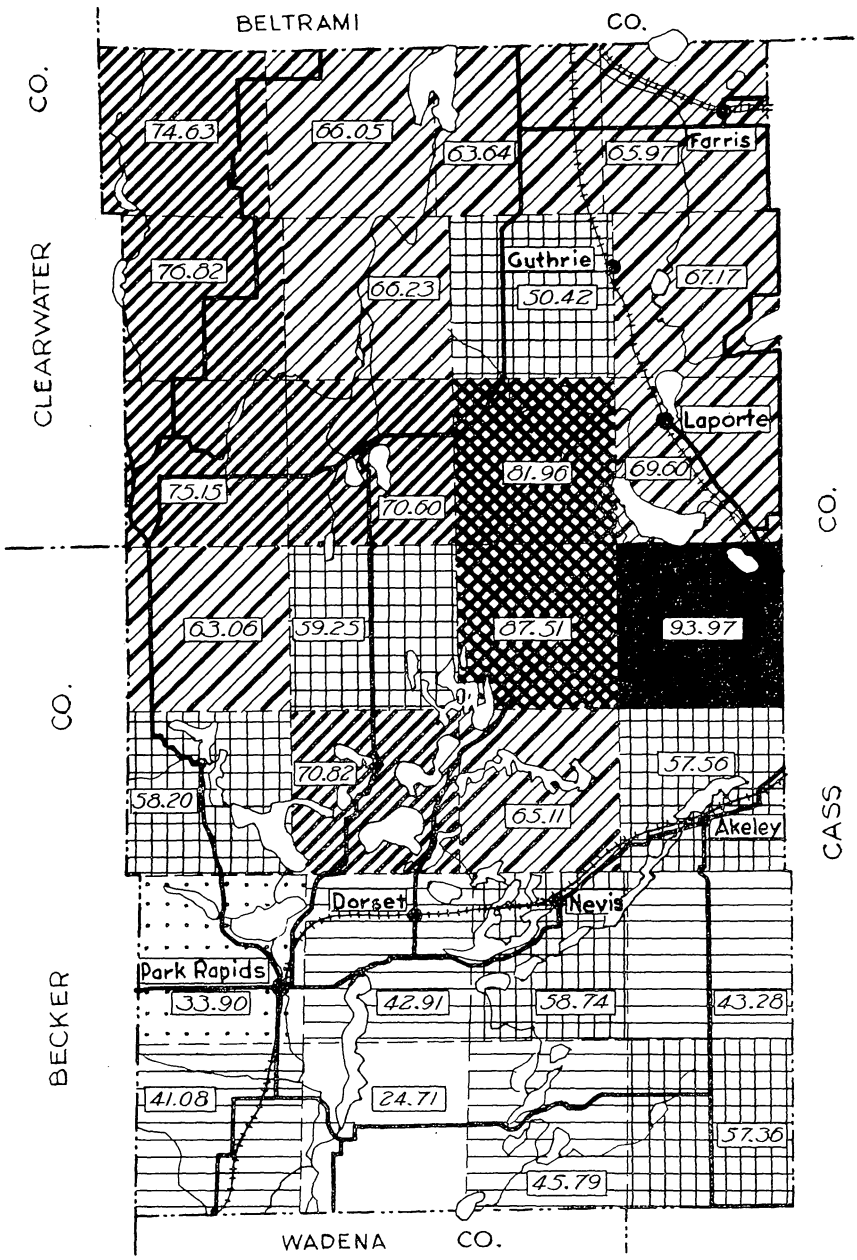

Fig. 48. Land in Forest Use in Percentages of the Area of the Various Townships, as Indicated by Planimeter Reading of Cover Map

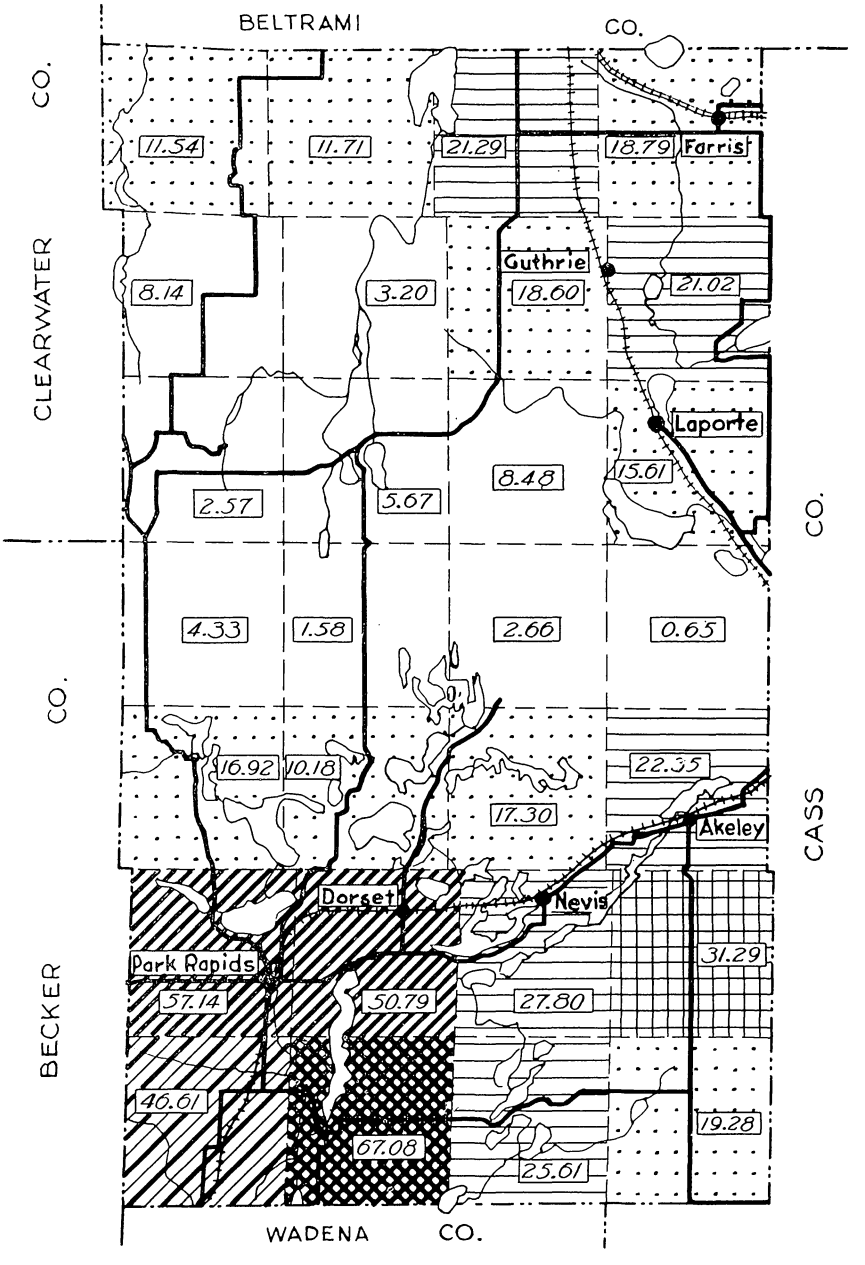

Fig. 49. Percentage of Total Area of Township in Actual Farm Use, as Indicated by Cover Survey

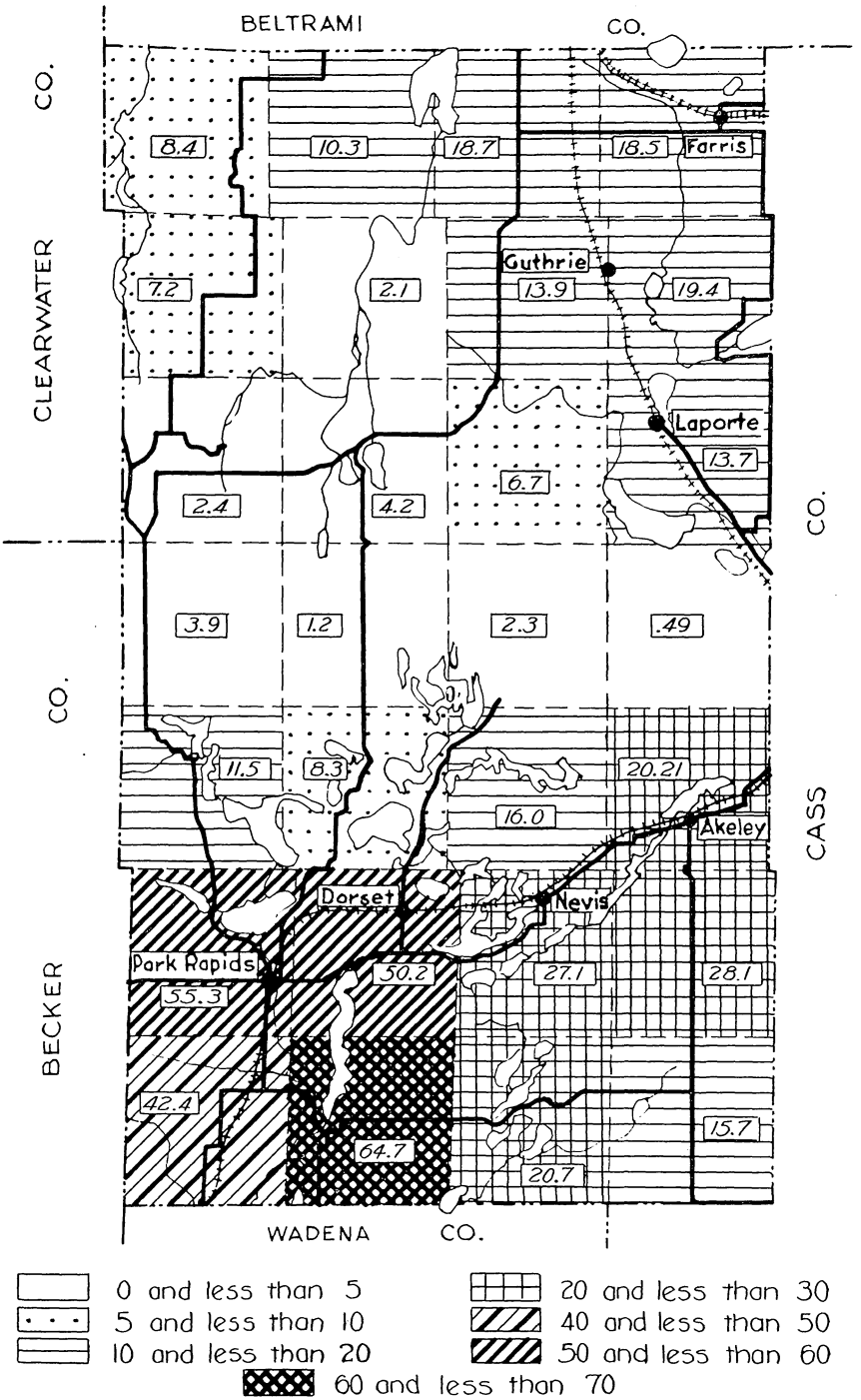

Fig. 50. Percentages of Township Area Plowable, as Indicated by Cover Survey

tered over 17 townships. Lake Emma had the largest area, about 900 acres, and Arago, second, had 400 acres. Other leading townships were Lakeport, Henrietta, Rockwood, and Crow Wing.

Farm resorts, including a total of about 720 acres, were found in 10 townships. Mantrap had about 30 per cent of this area. The others in order were Arago, Farden, Crow Wing, Lakeport, Steamboat River, Hart Lake, Todd, Akeley, and Fern. Non-commercial resorts, or "recreation grounds," are relatively unimportant, occupying only about 125 acres, mostly in Todd Township, with small areas in Henrietta and Akeley townships.

Summer homes were found in 21 of the 28 townships, occupying a total of 12,000 acres. Even tho the area is not large, this land use is important from the standpoint of tax revenue and summer business. Lake Emma is the leading township. Others are Nevis, Henrietta, Hubbard, Mantrap, Todd, Lakeport, Badoura, Steamboat River, Rockwood, Thorpe, and Helga.

Itasca State Park occupies 3,800 acres in Hubbard County, of which 3,300 acres are in Lake Alice Township, and 500 in Clover Township.

INDUSTRIAL AND RESIDENTIAL

Industrial and residential use claimed nearly 1,900 acres, including the areas within plotted villages and areas used for these purposes outside villages, the latter being relatively unimportant. The principal areas were found in the villages of Park Rapids, Akeley, Nevis, La Porte, Guthrie, Nary, Hubbard, and Dorset.

MISCELLANEOUS USES

Such miscellaneous uses as churches and school yards, cemeteries, and railroad right-of-ways required about 700 acres.

INFORMATION ON LAND USE FROM COVER SURVEY

The cover survey and mapping of the county furnished additional material on the use to which the land in the county was being put at the time the survey was made. Five general classes of cover were made as follows: (1) agricultural, (2) industrial, (3) forest, (4) waste, and (5) miscellaneous. The details of the results of the cover survey are shown in Tables 42 and 43.

The agricultural groups included cultivated land, cultivated stump land, pasture, stump pasture, mixed brush pasture, meadow-grass pasture, meadow-sedge pasture, meadow-grass or bluejoint meadow, stump meadow, farmyards, and abandoned land. The total area of land

Table 42

Agricultural Land Use Indicated by Cover Survey (By Planimeter Reading)

Township	Crop land	Abandoned crop land	Plowable pasture	Wild pasture	Wild meadow	Idle land in farms
	acres	acres	acres	acres	acres	acres
Akeley	3,522.00	369.00	463.00	383.00	84.00	5,919.00
Arago	1,959.00	216.00	132.00	226.00	918.00	4,021.00
Badoura	2,953.00	423.00	168.00	288.00	622.00	11,016.00
Clay	151.00	103.00	2.00	.....	84.00	4,169.00
Clover	746.00	93.00	12.00	.....	80.00	2,448.00
Crow Wing Lake	3,386.00	437.00	110.00	693.00	607.00	3,372.00
Farden	3,090.00	157.00	255.00	195.00	381.00	7,252.00
Fern	1,635.00	89.00	171.00	58.00	637.00	5,896.00
Guthrie	2,735.00	89.00	300.00	191.00	876.00	6,709.00
Hart Lake	3,769.00	39.00	398.00	280.00	135.00	8,044.00
Helga	3,639.00	81.00	305.00	349.00	73.00	6,925.00
Hendrickson	1,287.00	91.00	125.00	105.00	301.00	3,275.00
Henrietta	9,435.00	370.00	571.00	172.00	26.00	5,535.00
Hubbard	12,497.00	590.00	697.00	120.00	391.00	3,784.00
Lake Alice	367.00	67.00	84.00	35.00	28.00	1,264.00
Lake Emma	1,145.00	121.00	199.00	64.00	258.00	3,132.00
Lake George	556.00	173.00	169.00	54.00	271.00	3,522.00
Lake Hattie	1,306.00	86.00	120.00	27.00	177.00	3,771.00
Lakeport	1,964.00	258.00	448.00	166.00	215.00	5,386.00
Mantrap	2,878.00	303.00	103.00	133.00	140.00	5,751.00
Nevis	4,462.00	396.00	288.00	63.00	67.00	4,453.00
Rockwood	1,762.00	101.00	314.00	53.00	247.00	4,517.00
Schoolcraft	327.00	84.00	33.00	71.00	175.00	2,893.00
Steamboat River District	104.00	5.00	.....	.....	36.00	279.00
Straight River	8,995.00	296.00	207.00	336.00	660.00	6,382.00
Thorpe	383.00	94.00	29.00	29.00	63.00	2,511.00
Todd	9,813.00	771.00	678.00	408.00	180.00	4,637.00
White Oak	5,018.00	458.00	704.00	566.00	132.00	8,198.00
Total, county	89,884.00	6,360.00	7,085.00	5,065.00	7,864.00	135,061.00

actually in agricultural use was 115,000 acres, or 19 per cent of the total area and 46 per cent of the area dedicated to agricultural use.[5] In other words, less than half of the area dedicated to agricultural use was actually so employed at the time of the survey.

The largest area in actual farm use was found in Hubbard Township, with over 14,000 acres; the lowest in Steamboat River, with less than 150 acres. Other townships having over 10,000 acres in agricultural use were Todd, Henrietta, and Straight River. These are in the southwestern corner of the county. They were settled first and were partly prairie. Eleven townships had a larger proportion of their area in farm use than the average for the county. Nine of these are in the southern end and two are in the northeastern corner. The townships with the lowest amounts are found in a belt through the center and in the northwestern section.

The area mapped as covered by forest types comprised 368,000 acres, or 62 per cent of the area of the county. Steamboat River had

[5] The other 54 per cent of area dedicated to agriculture included secondary pasture, timber, or idle or waste land.

Table 43

Nonagricultural Land Use Indicated by Cover Survey

Township	Forest	Industrial	Miscellaneous	Waste	Water
	acres	acres	acres	acres	acres
Akeley	12,388.00	220.00	4.00	4,098.00	1,559.00
Arago	11,672.00	.....	2.00	4,989.00	2,643.00
Badoura	12,919.00	.....	5.00	5,145.00	445.00
Clay	12,773.00	.....	40.00	8,406.00	1,498.00
Clover	13,565.00	.....	.....	7,016.00	954.00
Crow Wing Lake	8,687.00	.....	.....	5,425.00	3,359.00
Farden	14,241.00	.....	9.00	3,282.00	1,563.00
Fern	16,753.00	.....	4.00	3,099.00	461.00
Guthrie	11,362.00	41.00	4.00	6,935.00	1,486.00
Hart Lake	14,535.00	.....	3.00	2,553.00	1,094.00
Helga	13,735.00	14.00	.....	3,237.00	1,428.00
Hendrickson	18,457.00	.....	2.00	2,152.00	425.00
Henrietta	8,806.00	28.00	20.00	1,252.00	2,160.00
Hubbard	5,267.00	76.00	3.00	1,670.00	1,615.00
Lake Alice	16,347.00	.....	2.00	4,844.00	552.00
Lake Emma	12,437.00	.....	9.00	3,329.00	5,378.00
Lake George	15,207.00	.....	.....	5,113.00	1,293.00
Lake Hattie	16,183.00	.....	.....	3,167.00	619.00
Lakeport	13,521.00	71.00	2.00	2,801.00	3,584.00
Mantrap	13,389.00	.....	.....	3,618.00	2,417.00
Nevis	11,153.00	118.00	32.00	2,405.00	3,099.00
Rockwood	13,966.00	.....	2.00	4,702.00	1,850.00
Schoolcraft	14,289.00	.....	.....	6,596.00	440.00
Steamboat River District	20,839.00	.....	.....	1,193.00	864.00
Straight River	9,191.00	8.00	4.00	2,741.00	575.00
Thorpe	19,424.00	.....	.....	2,182.00	840.00
Todd	6,904.00	401.00	37.00	1,387.00	2,226.00
White Oak	9,513.00	.....	13.00	5,576.00	1,023.00
Total, county	367,523.00	977.00	197.00	108,913.00	45,450.00

nearly 21,000 acres, or 94 per cent of its area, while Hubbard had a little over 5,000 acres, or 25 per cent of its area in this classification. Other leading townships were Thorpe, Hendrickson, Fern, Lake Alice, and Lake George. These are in the central and northwestern parts of the county. The townships with the lowest proportion of forest areas were Hubbard, Todd, Straight River, Henrietta, White Oak, and Guthrie.

Land classed as "waste" in the cover survey included brush, marsh, swamp, and open types not included in pasture or meadow and which were growing no cover of economic value. About 109,000 acres were so classified. The townships with the larger amounts of such land were Clay, Clover, Schoolcraft, and Guthrie. Steamboat River, having such a large proportion of its area in forest type, had the lowest amount of land classified as waste. It should be borne in mind that because this land was classified as waste land at the time of the survey does not mean that there may not be use found for it. Nor is all of the land so classified of equal value. Soil, topography, and accessibility must be considered.

Summarizing the results of the survey in intent of ownership and

the cover survey gives the following distribution of land use for the county:

Intent of Owners	per cent	Cover Survey	per cent
Agriculture	42.16	In agricultural use	19.47
Timber	54.21	Forest	61.97
Industrial and residential	0.31	Industrial and residential	0.16
Recreational	2.01	Recreational	0.01
Water power	1.20	Waste	18.36
Miscellaneous	0.11	Miscellaneous	0.03
	100.00		100.00

This comparison suggests the hope of owners that a considerable extension in the agricultural use of land in the county will take place but that timber growing will be reduced rather than extended.

THE AGRICULTURE OF HUBBARD COUNTY

James Compton put in the first crop in 1879—15 acres of rye. Potatoes and rutabagas were among the crops put in on new breaking by the early settlers. Cash grain crops, especially wheat and oats, were the most important crops in the early years of agricultural development. The first detailed record of the agriculture of Hubbard County was provided by the census of 1890. Tables 44, 45, and 46 summarize the agricultural information supplied by each census from 1890 to 1930.

As will be noted from these tables, the number of farms increased until 1925, a slight drop being shown by the 1930 census. The total area in farms likewise showed increases for each census except the

Table 44

Agricultural Development in Hubbard County by Census Periods

	1890	1900	1910	1920	1925	1930
Approximate area of county, acres	335,971	613,120	613,120	613,120	613,120	613,120
Total number of farms	194	641	843	1,252	1,442	1,304
Total area in farms, acres	34,999	99,143	151,984	191,996	202,488	197,052
Per cent of area in farms	10.4	16.2	24.8	31.3	33.03	32.14
Total acres in farm improved	16,706	29,509	55,699	80,323	90,393	85,521
Per cent of farm land improved	47.7	29.8	36.6	41.8	44.64	43.5
Average acreage per farm	180	154.7	180.3	153.4	140.4	151.1
Value of land and buildings	.....	922,870	2,671,660	8,931,071	7,110,852	5,737,389
Value of land in farms	.....	703,720	2,089,875	7,279,248	5,264,182	3,676,624
Value of buildings	.....	119,150	581,785	1,651,823	1,846,670	2,060,765
Value of livestock on farms	70,161	139,524	301,033	1,041,870	772,077	952,552
Average value of livestock on farms	362	218	357	832	535	730
Average value of land and buildings per farm	.....	1,284	3,169	7,133	4,931	4,400
Average value of land alone per acre	.....	7.10	13.75	37.91	26.00	18.66
Number of farms operated by owner	167	597	777	1,100	1,235	1,076
Number of farms operated by tenants	27	44	66	152	207	228
Per cent of farms operated by owners	86.1	93.1	92.2	87.9	85.6	82.5
Per cent of farms operated by tenants	13.9	6.9	7.8	12.1	14.4	17.5

last. While the proportion of farms operated by tenants has been increasing, the percentage (17) is considerably below that of the percentage for the state (31). The state average is raised by southern counties. The lower percentage in Hubbard County may be explained by the lower land values and the consequent smaller amount of capital required to purchase a farm.

A comparison of the land used for agriculture in Hubbard County with that for the entire state is shown in Table 47.

Table 45

Agricultural Production in Hubbard County by Census Periods

		1890	1900	1910	1920	1925	1930
Barley,	acres	147	109	292	579	980	3,776
	bushels	2,828	1,870	4,558	9,684	17,809	40,792
Buckwheat,	acres	5	59	57	837	394	211
	bushels	29	980	964	9,817	3,524	940
Corn,	acres	239	1,790	4,014	2,719	12,408	9,343
	bushels	5,742	42,400	106,044	68,549	12,821	7,050
Oats,	acres	2,906	2,603	10,377	12,065	18,214	14,604
	bushels	47,884	55,050	150,076	218,916	489,705	189,691
Rye,	acres	148	199	3,082	9,426	3,022	3,440
	bushels	1,368	2,240	39,121	90,541	49,572	26,199
Wheat,	acres	9,561	13,365	3,115	5,650	2,657	1,451
	bushels	138,084	176,810	28,657	45,983	37,863	9,140
Hay,	acres	167	2,384	15,196	22,654	27,440	29,910
	tons	199	2,556	15,035	36,122	21,816	19,652
Potatoes,	acres	165	394	1,927	4,575	2,704	3,091
	bushels	24,526	51,223	324,317	428,146	316,869	203,589

Table 46

Livestock and Livestock Products in Hubbard County

	1890	1900	1910	1920	1925	1930
All cattle	1,172	970	4,924	9,683	10,664	9,696
Dairy cattle	445	852	2,511	5,232	7,511	5,661
Horses	516	1,273	1,833	3,555	3,572	3,291
Mules	9	60	23	67	85	72
Swine	551	988	1,608	3,233	3,710	2,585
Sheep	105	1,008	2,311	5,269	2,335	7,390
Chickens	5,848	10,989	33,251	46,977	65,587	53,994
Livestock products						
Milk produced, gallons	137,493	306,348	780,537	2,007,633	2,428,938	3,427,671
Butter made, pounds	41,735	52,676	185,195	217,834	192,199	111,496
Cream sold, gallons	.....	.....	13,639	15,154	23,785	5,016
Butterfat sold, pounds	.....	.....	15,575	235,938	409,500	822,620
Fleeces shorn	83	638	1,354	3,757	1,161	4,272
Pounds of wool produced	471	3,385	10,127	25,138	7,920	28,620
Eggs produced, dozens	16,344	55,450	143,024	202,072	374.830	379,955

Table 47

Agricultural Development in Minnesota and Hubbard County by Census Periods

Year	State		Hubbard County	
	Per cent land area in farms	Per cent farm land improved	Per cent land area in farms	Per cent farm land improved
1890	36	60	10	48
1900	51	70	16	30
1910	53	71	25	37
1920	58	71	31	42
1925	58	88	35	45
1930	60	70*	32	43*

* Estimated—Crops harvested, crop failure, fallow land, plowable pasture.

Figure 51 shows the location of primary farm markets in 1930.

The primary agricultural markets serving the county are the villages located within its borders, Bemidji, which is within three miles of the northern boundary, and, to a slight extent, Cass Lake and Walker.

Three creameries, one co-operative and the others privately owned, are located in the county, the largest being in Park Rapids. Three creameries, located at Bemidji, are also outlets for butterfat. There were also 13 cream stations in the county, 4 at Park Rapids, 3 at Akeley, and 2 at Guthrie, Nevis, and Dorset.

Local market outlets for potatoes were supplied by 13 potato warehouses, 11 in the county and 2 in Bemidji. Park Rapids, Nevis, Akeley, and Rosby each had 2 warehouses and La Porte, Guthrie, and Horton had one each.

Three livestock shipping associations were found in the county, at Park Rapids, Nevis, and Guthrie. A fourth association at Bemidji serves a section of the county. In addition, there were private buyers of livestock.

Three grain elevators in the county, at Park Rapids, Dorset, and Akeley, served the county, and a fourth was located at Bemidji. Grain shipments were not heavy, as practically as much grain and feed were brought in as were shipped out.

Poultry and eggs are marketed at produce stations, local stores, and cream stations. Three stations at Park Rapids handle poultry products. The north end of the county has access to a large poultry plant at Bemidji. Fruits, vegetables, and various other farm products are sold to local stores.

Summer resorts located in the county, both commercial and private, supply a market for some products. It seems likely that this outlet can be increased by paying more attention to the kind and quality of products in demand by such outlets.

Figure 52 shows the number of farms per township according to the census of 1930.

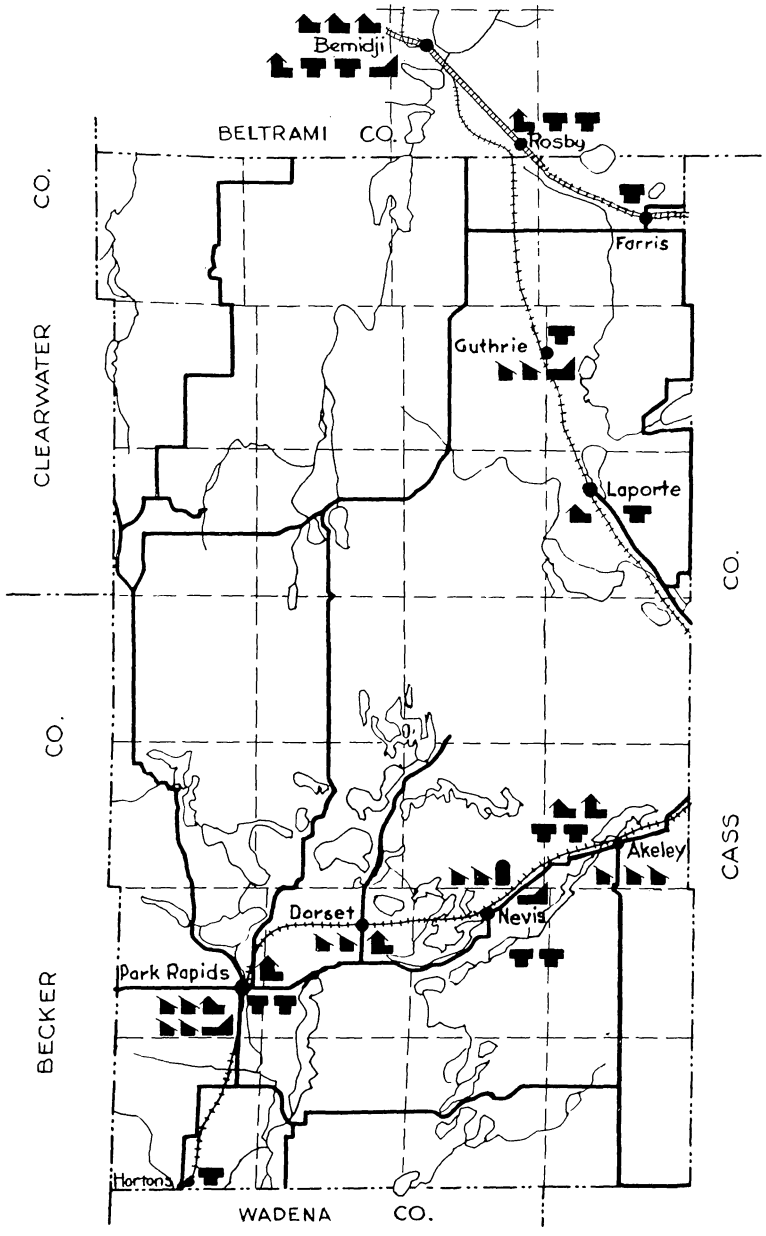

Fig. 51. Primary Farm Markets, 1930

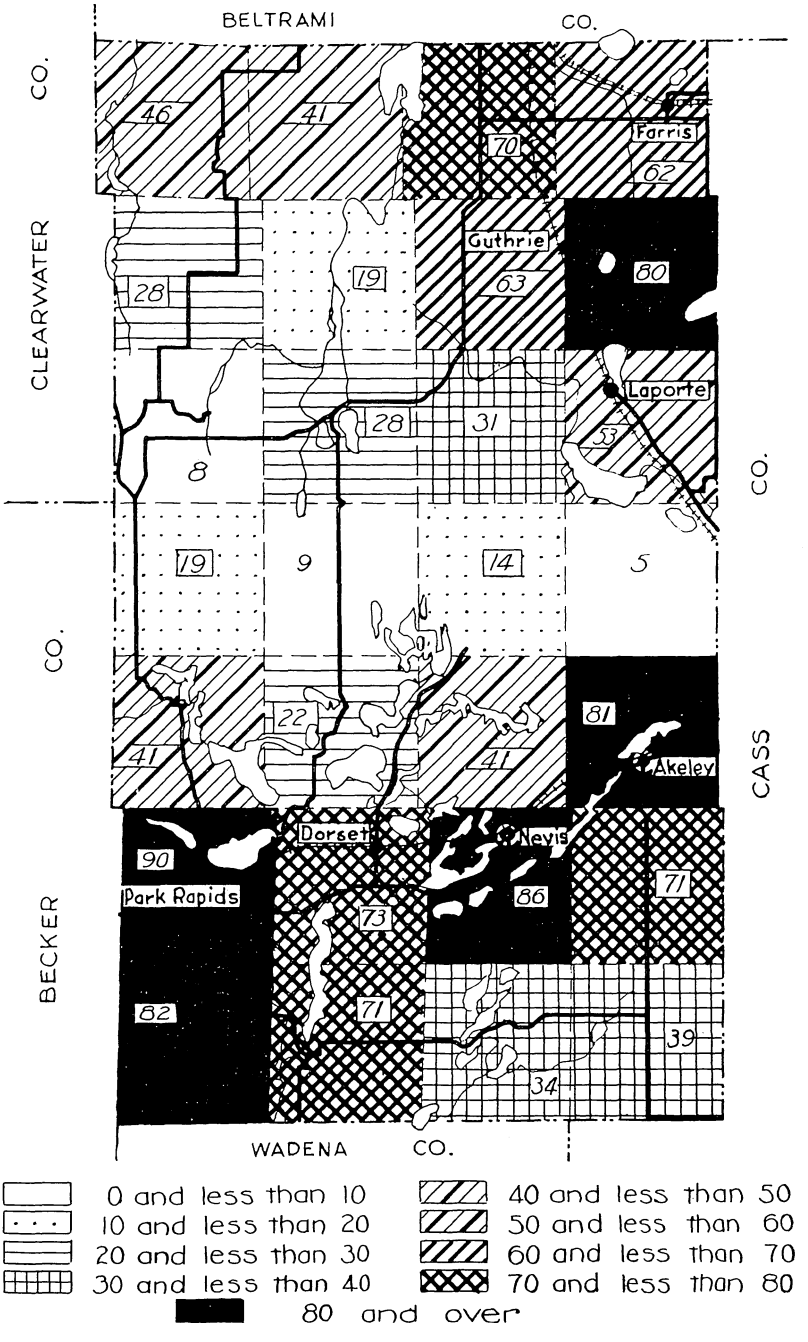

Fig. 52. Number of Farms Per Township, 1930 Census

VI. THE FORESTS OF HUBBARD COUNTY[1]

THE ORIGINAL FORESTS

The greater part of the territory surrounding the headwaters of the Mississippi River was originally covered with dense coniferous forests of pine, spruce, and balsam.

In the virgin forest of Hubbard County the types that were undoubtedly most prominent were: (1) Norway pine, pure or mixed with white pine, on the moraine through the central part of the county, (2) pure jack pine on the dry sand plains, (3) mixed conifers and hardwoods on the heavier soils in the northeast, (4) black spruce, tamarack and cedar in small swamps scattered throughout the county, and (5) oak on a few scattered areas in the southern part of the county. There was a small open area near Hubbard and Park Rapids.

Field notes of the General Land Office surveys indicate that, even before lumbering began in a large way or settlement progressed to any extent in the forest region, the character of the forest had undergone important changes due, no doubt, to extensive forest fires. Maps prepared from these early surveys indicate that jack pine dominated many areas normally occupied by white and Norway pine and had laid claim to over two-fifths of the entire county. Aspen, a minor constituent in the virgin forest, had replaced hardwoods and white pine on over a quarter of the area of the county.

Percentages of area, as indicated by these old notes, were about as follows:

Jack pine	45%
Aspen	29%
Spruce, cedar, tamarack	9%
Hardwood and pine	1%
White and Norway pine	8%
Oak	5%
Non-forest	3%
	100%

Lumbering brought about further changes in the character of the forest. Prof. E. G. Cheyney estimates that, all told, over 3.3 billion board feet of pine have been removed from this county. During this

[1] This chapter prepared by R. N. Cunningham, Lake States Forest Experiment Station, summarizes forest area and volume figures obtained by the field mapping parties directed by Raymond Stevens and E. L. Lawson and sampling surveys made by Robert T. Anderson. The analysis of soil data was made by Eugene Roe, Lake States Forest Experiment Station.

process the virgin forest has practically disappeared, and most of the second growth has been culled over repeatedly for sawlogs, lath bolts, and pulpwood. Fires, following logging, have been common and today the characteristic forest growth is small jack pine of patchy distribution on the sandier areas, young aspen on the heavier soils, and culled-over black spruce in the swamps.

PRESENT FOREST AREAS

The forest cover map, completed in 1930, shows 446,132 acres or three-fourths of the land area of Hubbard County to be forest land. In round figures, 66 per cent of this area is taken up with aspen and other replacement types, 22 per cent with pine, mainly jack pine, 8 per cent with coniferous swamp types, and 4 per cent with miscellaneous hardwoods of generally inferior quality, such as maple, basswood, oak, black ash, and elm.

After 30 years of lumbering, frequent forest fires, several serious insect epidemics, attempted cultivation, and later abandonment of many sandy areas, it is not surprising that the forests of Hubbard County are in a very much depleted and run-down condition.

Only a few hundred acres of virgin forest remain—all embraced in Itasca State Park or in a few privately-owned summer homesites. There are, altogether, only 4,419 acres that bear timber of sawtimber size and only 35,132 acres of merchantable pulpwood dimensions. There are 130,233 acres of advanced reproduction, which, with care, will reach pulpwood size in 10 years or less. The remaining 276,348 acres are either bare or covered with very young reproduction. The details of types and sizes are given in Table 48. (See also forest map.)

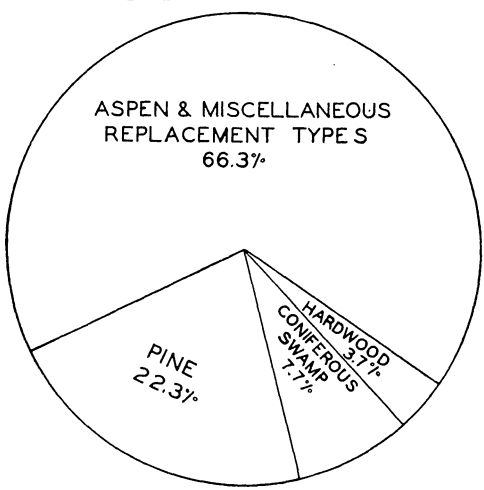

Fig. 53. Proportions of Forest Types in Hubbard County

THE PINE FORESTS

Altho pine forests originally covered almost three-fourths of the area of Hubbard County, they are now reduced to 99,219 acres, which is only one-sixth of the county area or about 27 per cent of the

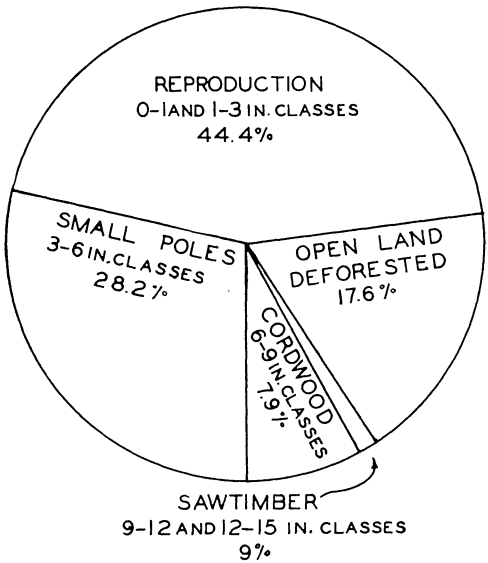

Fig. 54. Classification of Hubbard County Timberland by Diameter Sizes

total forest area. Jack pine is the principal species on 94,418 acres, Norway pine on 4,336 acres, and white pine on 310 acres. Mixed pine with spruce and balsam occupies 155 acres.

Areas of sawtimber size in the pine types total 3,127 acres. Those of pulpwood size amount to 15,751 acres. Of the total pine area, 16,110 acres, or 16 per cent, have been classified as well stocked[2]; 42,746 acres, or 43 per cent, as medium stocked; 27,386 acres, or 28 per cent, as poorly stocked, while 12,822 acres, or 13 per cent, have only a few scattered trees. The acreage under each size and density class is shown in Table 49.

Some very nice stands of young jack pine from 6 to 12 inches in diameter are still found in Hubbard County, usually in small woodlots or along lakeshores reserved for recreational purposes. The characteristic jack pine stand, however, is made up of smaller trees, 3 to 6 inches in diameter or even smaller, and is patchy in appearance, showing the signs of recent cutting and numerous grass fires. Throughout the areas originally covered with white and Norway pine, a few scattered seed trees of larger diameter remain, and in places not too severely burned, white and Norway pine seedlings make up an appreciable proportion of the reproduction. Table 50 is a stand table for an average acre based upon 7.95 miles of strip survey run through medium-stocked jack pine of the 3- to 6-inch diameter class.

Enough large-sized jack and Norway pine trees have been left over from the earlier stand and enough of the new crop has reached

[2] As defined in the mapping of Hubbard County well-stocked stands are those in which the trees are so closely spaced that there is little or no waste land and light, and the individual trees develop small crowns and tall, clean, straight boles. In medium-stocked stands, the trees are less numerous, and the crowns are larger and more irregular. In poorly-stocked stands, the trees are so few and scattered that there is a very material waste of land and light. Many individual trees develop spreading and limby crowns and short knotty trunks.

cordwood size (6 inches d.b.h.) to make up on an average 8⅓ cords per acre, or nearly one thousand board feet.

A summary of the stand per acre on different densities and size classes of jack pine, as shown on the type map, is given in Table 51.

Table 48

Summary of Acreages by Types

Types	Reproduction 0-1 inches and 1-3 inches diameter class	Small Poles 3-6 inches diameter class	Merchantable Cordwood 6-9 inches diameter class	Sawtimber 9-12 inches 12-15 inches diameter class	Total
Pine forests					
Jack pine	30,284	48,377	14,496	1,261	94,418
Norway pine	113	1,410	1,152	1,661	4,336
White pine	4	51	50	205	310
Pine, balsam	.....	102	53	.....	155
Total	30,401	49.940	15,751	3,127	99,219
Aspen, etc.					
Aspen	145,580	48,849	9,778	551	204,758
White birch	9,227	3,014	129	4	12,374
Brush, grass, open	78,531	.....	.....	.....	78,531
Total	233,338*	51,863	9,907	555	295,663*
Coniferous swamps					
Spruce, balsam	1,504	20,467	2,791	11	24,773
Tamarack	4,607	4,402	290	.....	9,299
Cedar	117	315	.....	6	438
Total	6,228	25,184	3,081	17	34,510
Miscellaneous hardwood types					
Maple, basswood	257	1,804	4,323	468	6,852
Oak	6,109	289	267	150	6,815
Hardwood swamp	15	1,153	1,803	102	3,073
Total	6.381	3,246	6,393	720	16,740
Total forest	276.348*	130,233	35,132	4,419	446,132
Non-forest land	.....	.....	.....	.....	147,001
Water	.....	.....	.....	.....	45,450
Total, county	.....	.....	.....	.....	638,583

* Includes 78,531 acres of deforested land.

Table 49

Acreage of Pine Types by Sizes and Densities

Densities	Diameter classes*								
	0–1	1–3	3–6	6–9	9–12	12–15	15–18	18+	Total
	acres	acres	acres	acres	acres	acres	acres	acres	acres
Jack pine—Pj									
Good	793	5,846	7,945	1,184	244	...	...	..	16,012
Medium	1,979	9,688	22,066	7,203	652	...	...	..	41,588
Poor	2,107	7,153	11,642	4,071	317	12	...	..	25,302
Scattered	946	1,772	6,724	2,038	36	...	...	..	11,516
Total	5,825	24,459	48,377	14,496	1,249	12	...	..	94,418
Norway pine—Pn									
Good	....	10	46	29	13	...	...	..	98
Medium	....	20	534	283	226	40	6	..	1,109
Poor	....	64	496	548	584	73	162	4	1,931
Scattered	....	19	334	292	443	100	10	..	1,198
Total	....	113	1,410	1,152	1,266	213	178	4	4,336
White Pine—Pw									
Good	....	....	....	....	....	...	...	..	....
Medium	....	....	8	....	32	9	...	..	49
Poor	....	4	20	44	75	10	...	..	153
Scattered	....	....	23	6	73	6	...	..	108
Total	....	4	51	50	180	25	...	..	310
Mixed pine—Ps, Pba									
Good	....	....	....	....	....	...	...	..	....
Medium	....	....	55	37	....	...	...	..	92
Poor	....	....	15	9	....	...	...	..	24
Scattered	....	....	32	7	....	...	...	..	39
Total	....	....	102	53	....	...	...	..	155

* The stands are described in terms of predominant tree size. The 6-9 diameter class has trees ranging from 1 inch diameter up to 12 inches or even larger, but the bulk of the stand is made up of trees 6, 7, 8, and 9 inches in diameter.

Table 50

Sample Acre of 3- to 6-inch Jack Pine, Medium Stocked

Diameter breast high, inches	Number of trees					
	Jack pine	Norway pine	White pine	Aspen, W. birch	Other species	Total
1-2-3	434.7	31.7	10.0	10.0	10.9	497.3
4-5-6	221.0	10.9	0.5	12.8	2.6	247.8
7-8-9	45.6	3.8	0.1	3.0	0.3	52.8
10-11-12	11.7	3.2	...	0.5	0.1	15.5
13-14-15	1.3	0.8	...	...	...	2.1
16-17-18	....	0.5	...	...	...	0.5
Total	714.3	50.9	10.6	26.3	13.9	816.0

Table 51

Sample Acres, Jack Pine Type

Size, inches	Densities	No. of trees over 3½ inches	Total volume, cu. ft.*	Total cordwood volume, cords†	Total bd. ft. volume (Scribner dec. C)‡	Basis, no. of acres
3–6	Good	493	1485	8.8	325	3.6
	Medium	319	1236	8.3	988	15.9
	Poor	253	1097	7.9	1319	5.3
	Scattered	87	339	2.6	139	5.9
6–9	Good	391	2450	24.5	3309	5.5
	Medium	344	2177	21.6	3211	25.3
	Poor	162	1395	13.4	2203	1.5
	Scattered	91	752	7.3	2051	5.0
9–12	Good	304	2651	28.4	6376	2.7
	Poor	91	1306	14.0	4183	0.9
	Scattered	42	564	5.5	1587	0.4

* The cubic foot volume includes the entire volume of the tree stem with stump and tip, but excludes bark and limbs.

† The cordwood estimate excludes the stump and the tip above a 3-inch diameter. It is figured only for trees 6 inches and larger in diameter at breast height.

‡ The board foot volume gives the Scribner decimal C log scale to a 6-inch minimum top. It is figured only for trees 10 inches or larger in diameter at breast height.

ASPEN AND OTHER REPLACEMENT TYPES

Some 295,663 acres, or about one-half of the county, are covered with young stands of aspen and paper birch or are completely deforested and covered only with brush, grass, and ferns. Some of the aspen areas, particularly in the northeastern part of the county, have commercial possibilities, but the greater part are so young and understocked that they may be included with the completely deforested land as far as immediate commercial values are concerned. Only 555 acres in these types bear stands of sawlog size. As to density, 6,602 acres, or 2 per cent of the area, are classified as well stocked; 100,868 acres, or 34 per cent, as medium stocked; 102,771 acres, or 35 per cent, as poorly stocked; 6,891 acres, or 2 per cent, as very poorly stocked, while 78,531 acres, or 27 per cent, are classified as open land. The 78,531 acres of deforested land are covered mainly with brush species such as hazel, fire cherry, willow, dogwood, service berry, etc. About 1,180 acres of it are covered with slash, and 1,359 acres merely with grass, bracken, and sweet fern.

The details of acreage are contained in Table 52.

The composition of the aspen stands is interesting because it sheds some light upon what the future development of the stands may be. In most stands, aspen makes up from 60 to 80 per cent of the cordwood volume, but there is usually a good representation of other species of hardwood and even of pine, especially in the smaller trees. A sample acre of medium-stocked aspen 3 to 6 inches in diameter is presented in Table 53. This is based upon 808 chains of sample strips.

Taking the aspen type as a whole, aspen and paper birch make up about three-fourths of the stand in number of trees, the aspen outnumbering the birch three to one. White pine is conspicuous in a few

localities, but on the whole is relatively scarce. Hardwoods, maple, and basswood, in particular, are quite well represented, especially in the northeastern part of the county.

The quantity of timber of all species in the various size and density classes can be judged from the sample acre determinations shown in Table 54.

Table 52

Acreage of Aspen and Paper Birch Types By Sizes and Densities

Types Densities	Diameter classes						
	0–1	1–3	3–6	6–9	9–12	12+	Total
	acres	acres	acres	acres	acres	acres	acres
Aspen—Ha							
Good	2,859	1,682	1,715	274	...	..	6,530
Medium	20,036	44,237	27,918	5,460	323	..	97,974
Poor	37,181	36,429	16,835	3,507	172	..	94,124
Scattered	1,208	1,948	2,381	537	44	12	6,130
Total	61,284	84,296	48,849	9,778	539	12	204,758
White birch—Hb							
Good	.....	54	18	....	...	..	72
Medium	15	1,669	1,210	....	...	..	2,894
Poor	1,502	5,562	1,538	45	...	..	8,647
Scattered	131	294	248	84	4	..	761
Total	1,648	7,579	3,014	129	4	..	12,374
Open or brush land	.....	.....	.....	....	...	..	78,531
Hazel, willow, etc.							75,991 acres
Slash							1,181 acres
Grass, sweet fern, etc.							674 acres
Fresh burn							685 acres

Table 53

Sample Acres of 3- to 6-Inch Aspen, Medium Stocked

Diameter breast high, inches	No. of trees							
	Aspen	Paper birch	Maple, bass-wood, oak	White, Norway pine	Jack pine	Balsam, spruce	Misc.	Total
1–2–3	286.2	164.6	44.5	8.8	42.2	3.2	11.9	561.4
4–5–6	184.8	49.3	14.8	5.3	3.6	1.6	14.9	274.3
7–8–9	25.0	3.4	1.9	1.4	1.3	0.3	0.5	33.8
10–11–12	3.7	0.6	1.0	0.1	0.6	0.3	0.2	6.5
13–14–15	0.4	....	0.2	0.2	0.1	..	...	0.9
16–17–18	0.2	....	...	0.1	0.1	..	...	0.4
Total	500.3	217.9	62.4	15.9	47.9	5.4	27.5	877.3

Table 54

Sample Acres, Aspen Type*

Size	Densities	No. of trees over 3½ inches d.b.h.	Total volume, cu. ft.	Net cord-wood volume, 6 inches and over, cords	Bd. ft. volume, Scribner dec. C, 10 inches and over	Basis, no. of acres
	Good	459	1901	10.4	1251	5.6
	Medium	316	1149	5.8	466	20.2
3–6	Poor	181	848	4.1	463	5.2
	Scattered	84	283	1.8	....	0.3
6–9	Medium	350	1903	14.7	1917	10.5
9–12	Medium	246	2483	18.4	3914	2.3
	Poor	218	1498	11.4	1929	1.1

* See footnotes, Table 51.

CONIFEROUS SWAMPS

Out of some 67,963 acres of swampy or wet land in Hubbard County, 34,510 acres are covered with coniferous forests. The spruce type is the most important, occupying about two-thirds of the total. Tamarack ranks second, while cedar is relatively unimportant, with only 438 acres in the county.

There is practically no sawtimber in the swamp types. Stands classified as of pulpwood size are found on 3,081 acres. In addition, there are nearly 20,000 acres of fairly thrifty young spruce which contain some cordwood at the present time and can be expected to produce pulpwood stands in a reasonably short time.

Only 1,144 acres, or 3 per cent of the swamp forests, are rated as of good density. This is doubtless due to much recent cutting. There are 11,048 acres, or 32 per cent of the total, of medium density, and 19,811, or 58 per cent, of poor density. There are, in addition, 2,507 acres, or 7 per cent of the total acreage, which contain only scattered forest growth. The details for all densities are shown in Table 55.

Table 55

Acreage of Coniferous Swamp Types by Sizes and Densities

Types Densities	Diameter classes								
	0–1	1–3	3–6	6–9	9–12	12–15	15–18	18+	Total
	acres	acres	acres	acres	acres	acres	acres	acres	acres
Spruce—Ss, Sba									
Good	....	21	384	17	...	...	...	..	422
Medium	....	123	7,045	128	...	...	...	..	7,296
Poor	134	940	12,218	2,508	11	...	...	..	15,811
Scattered	....	286	820	138	...	...	...	..	1,244
Total	134	1,370	20,467	2,791	11	...	...	..	24,773
Tamarack—St									
Good	55	242	425	....	...	...	...	..	722
Medium	....	2,322	1,346	30	...	...	...	..	3,698
Poor	2	1,711	1,653	250	...	...	...	..	3,616
Scattered	13	262	978	10	...	...	...	..	1,263
Total	70	4,537	4,402	290	...	...	...	..	9,299
Cedar—Sc									
Good	....	....	....	....	...	...	...	..	....
Medium	....	36	18	....	...	...	...	..	54
Poor	....	81	297	....	6	...	...	..	384
Scattered	....	....	....	....	...	...	...	..	....
Total	....	117	315	....	6	...	...	..	438

The swamps of Hubbard County are relatively small and reasonably well drained as compared with the swamps of Beltrami and Koochiching counties. They exceed the majority of these larger swamps in timber-growing capacity.

The composition of a typical black spruce swamp is indicated in Table 56, which is based upon 444 chains of sample strips.

Table 56

Sample Acre, Medium Stocked, 3- to 6-Inch Spruce Type

Diameter breast high, inches	No. of trees by species						
	Black spruce	Balsam	Tamarack	Aspen, birch	Ash	Cedar	Total
1–2–3	393	46	28	1	5	5	478
4–5–6	105	44	16	8	4	2	179
7–8–9	13	9	4	2	1	1	30
10–11–12	5	1	1	..	..	.	7
13–14–15	...	...	..	1	..	.	1
16–17–18	1	...	..	..	..	.	1
Total	517	100	49	12	10	8	696

The average stand per acre for different size and density classes of the spruce type is shown in Table 57.

Table 57

Sample Acres, Spruce Type*

Size, inches	Densities	No. of trees over 3½ inches d.b.h.	Total volume, cu. ft.	Cordwood volume, 6 inches and over, cords	Basis, no. of acres
	Good	600	1,144	0.8	0.5
3–6	Medium	218	805	4.2	25.4
	Scattered	46	231	0.6	0.8
6–9	Good	336	1,495	12.2	2.0
	Poor	194	972	8.2	1.4

* See footnotes, Table 51.

Table 58

Acreage of Miscellaneous Hardwood Types by Sizes and Densities

Types Densities	Diameter classes								
	0–1	1–3	3–6	6–9	9–12	12–15	15–18	18+	Total
	acres	acres	acres	acres	acres	acres	acres	acres	acres
Oak—Ho									
Good	7	....	8	....	...	...	...	..	15
Medium	387	576	152	22	...	...	...	..	1,137
Poor	2,800	2,127	118	172	45	...	...	..	5,262
Scattered	99	113	11	73	97	8	...	..	401
Total	3,293	2,816	289	267	142	8	...	..	6,815
Maple—Hm									
Good	....	....	97	23	...	...	...	..	120
Medium	50	84	697	2,245	111	...	21	..	3,208
Poor	....	46	770	1,537	288	18	...	..	2,659
Scattered	....	77	240	518	22	8	...	..	865
Total	50	207	1,804	4,323	421	26	21	..	6,852
Hardwood swamp—Hs, Hba, Shm									
Good	....	....	....	27	...	...	...	..	27
Medium	....	12	352	470	63	10	...	..	907
Poor	....	1	661	1,120	21	...	...	..	1,803
Scattered	....	2	140	186	...	8	...	..	336
Total	....	15	1,153	1,803	84	18	...	..	3,073

MISCELLANEOUS HARDWOOD TYPES

Hardwood types occupy about 16,741 acres, or less than 4 per cent of the forest area. These are made up of 6,852 acres of maple-basswood, 6,816 acres of oak, and 3,073 acres of swamp hardwoods. There

is practically no commercial timber on these areas. Maple and basswood in this locality are not very thrifty and are subject to early rot. Oak is usually of the so-called scrub-oak variety, valuable only for firewood, posts, and occasionally ties. The acreage of each type by sizes and densities is given in Table 58.

MERCHANTABLE STANDS

There are, altogether, about 189 million board feet of timber left in Hubbard County. Most of this, however, is scattered in very light stands over the cut-over areas. Only 23 million feet, or 12½ per cent of the total, are on merchantable sawtimber areas, that is, in tracts of sufficient size and density to justify logging operations. Incidentally, the greater part of this sawtimber area is reserved for park or resort purposes and is not available for logging.

In addition to the sawtimber, there are over one million cords of smaller timber, approximately half of which is pine, spruce, and balsam, species suitable for pulpwood. As in the case of sawtimber, much of this cordwood is scattered thinly over cut-over and burned-over lands and may not justify commercial logging. Only about 400,000 cords are to be found on strictly cordwood areas.

The amount of standing timber by species and class of material is given in Table 59.

The average stand of sawtimber on the entire forest area in Hubbard County is only 423 board feet per acre. The average stand per acre on sawtimber areas is 5,315 board feet. A selected plot in the virgin Norway pine stand in Itasca Park indicated a volume of 38

Table 59

Sawtimber and Cordwood by Species, Hubbard County, Minnesota

Species	Thousand bd. ft. in trees 10 inches and over,* d.b.h.	Additional cords in trees 6 inches and over,† d.b.h.
White pine	4,864	10,828
Norway pine	34,123	41,352
Jack pine	71,289	452,342
White spruce and balsam	1,903	10,348
Black spruce	....	59,060
Balsam (swamp)	....	31,877
Oak	1,818	12,837
Tamarack	....	1,728
Aspen	44,471	363,032
White birch	2,391	29,139
Basswood } Maple }	931	4,930
Miscellaneous	491	4,142
Elm	....	1,164
Ash	....	5,830
Minor types (all species)	26,611	104,867
Total	188,892	1,133,476

* Sawtimber volume is expressed in thousand board feet, log scale by Scribner decimal C scale. It is figured only in trees 10 inches or larger in diameter.

† Cordwood is expressed in standard cords 4x4x8 feet—wood piled with bark on. The gross cordwood volume of the county is 1,511,260 cords from which the equivalent of the sawtimber volume has been deducted. (188,892 M.B.F. at 2 cords per M = 377,784 cords.)

thousand board feet per acre. The average for all virgin Norway pine, however, is about 15 thousand board feet. Because of the predominance of only partly stocked stands, the average for the pine types as a whole on areas of sawtimber is but six thousand board feet.

There is an average stand of 2½ cords of cordwood, about half of conifers and half of hardwoods, mostly aspen, on the 446,132 acres of forest land. The average stand on strictly cordwood areas is 11½ cords per acre, and there is a little over 10 cords of smaller material on the sawtimber areas. Scattered larger trees and thrifty second growth which has reached cordwood size on cut-over areas make an average stand of 1.7 cords per acre on the reproduction areas.

Pine lands as a whole average 1,000 board feet and 5.2 cords per acre; aspen lands, 200 board feet and 1.5 cords; coniferous swamps, 200 board feet and 3.5 cords, and miscellaneous hardwoods 1,100 board feet and 4.1 cords. Details are given in Tables 60 and 61.

Table 60

Summary of Sawtimber Stands, by Types, In Trees 10 Inches and Over in Diameter Breast High

	On sawtimber areas	On cordwood areas	On reproduction areas	Total
Pine types				
Total stand MBF	19,694	43,640	40,129	103,463
Stand per acre BF	6,298	2,771	499	1,043
Aspen, white birch, etc.				
Total stand MBF	2,197	29,051	29,206	60,454
Stand per acre BF	3,959	2,932	102	204
Coniferous swamp				
Total stand MBF	85	1,683	5,000	6,768
Stand per acre BF	5,000	546	159	196
Miscellaneous hardwoods				
Total stand MBF	1,512	15,287	1,408	18,207
Stand per acre BF	2,100	2,391	146	1,088
All types				
Total stand MBF	23,448	89,661	75,743	188,892
Stand per acre BF	5,315	2,552	186	423

Table 61

Summary of Additional Cordwood Volume, by Types, In Trees Six Inches and Over in Diameter Breast High

	On sawtimber areas	On cordwood areas	On reproduction areas	Total
	cords	cords	cords	cords
Pine types				
Total stand	34,262	189,850	289,662	513,774
Per acre	11.0	12.1	3.6	5.2
Aspen, white birch, etc.				
Total stand	6,888	142,022	282,782	431,692
Per acre	12.4	14.3	1.0	1.5
Coniferous swamp				
Total stand	.....	25,605	94,439	120,044
Per acre	.....	8.3	3.0	3.5
Miscellaneous hardwoods				
Total stand	5,046	50,506	12,414	67,966
Per acre	7.0	7.8	1.3	4.1
All types				
Total stand	46,196	407,983	679,297	1,133,476
Per acre	10.5	11.6	1.7	2.5

GROWTH OF FORESTS

The forests of Hubbard County are adding about 0.18 of a cord per acre per year through growth. This means a total increment of about 78,000 cords each year in the county.

There is considerable variation in the rate of growth between different types and between stands of different sizes and different densities. The pine type, as a whole, is growing at the rate of about four-tenths of a cord per acre per year, the hardwood types about two-tenths of a cord, and the aspen and the coniferous swamp types only one-tenth of a cord.

Well-stocked aspen stands are among the fastest growers. The best 3- to 6-inch stands are adding 0.62 cords each year, and the 6- to 9-inch stands of best density are putting on 0.47 cords. In this type, however, there is such a large acreage of very young stands, as well as a considerable acreage of practically denuded land, that the current growth for the type as a whole is very low.

The growth of black spruce, tamarack, and cedar in swamps is slow, and much of the present growth is taking place on trees too small to count as cordwood material. The average growth of only one-tenth of a cord per acre is thus accounted for.

The growth for each type is given in Table 62.

Table 62

Annual Growth of Forests in Hubbard County
(Predicted Annual Growth in Cords for Next 10 Years)

	On saw-timber areas	On cord-wood areas	On reproduction areas	Total
	cords	cords	cords	cords
Pine types				
Total annual growth	486	4,969	34,840	40,295
Per acre	.16	.32	.44	.40
Aspen, white birch, etc.				
Total annual growth	169	4,269	27,215	31,653
Per acre	.30	.43	.10	.11
Coniferous swamp				
Total annual growth	2	349	2,830	3,181
Per acre	.12	.11	.09	.09
Miscellaneous hardwoods				
Total annual growth	131	1,989	1,003	3,123
Per acre	.18	.31	.10	.19
All types				
Total annual growth	788	11,576	65,888	78,252
Per acre	.18	.33	.16	.18

VALUE OF VARIOUS SOILS FOR FORESTRY PURPOSES

There is known to be a relationship between the character of the soil and the nature and thriftiness of the forest that grows upon it. Some soils seem naturally to support pine forests; others, hardwood forests. On some soils trees such as aspen grow rapidly and make

good sound timber, while on other soils they grow slowly and become rotten before they reach even pulpwood size. If the exact nature of this relationship could be determined, it would be of inestimable value in determining the best use of various kinds of land in Hubbard County.

In the course of the forest survey of Hubbard County, several thousand measurements were taken to determine the composition of the stands on the various soils and the site index, which is a measure of the rate of growth which can be expected on these soils. While the differences are not as clear cut as might be desired, the facts uncovered are of sufficient significance to suggest the relative values of the more important soils for forestry purposes.

Table 63 shows the more common occurrence of conifers on certain soils.

Table 63

Reproduction by Soil Types as Shown by Mil-Acre Tally on 62 Miles of Strip Surveys

Soil type	Per cent of area restocking	Per cent stocked with conifers	Conifers, per cent of total
Menahga loamy sand	46	44	96
Marquette loamy sand	28	10	36
Arago loamy sand	44	8	18
Marquette sandy loam	29	7	24
Rockwood loamy sand	26	3	12
Rockwood sandy loam	40	1	3
Rockwood loam	40	less than 1	2
Nebish loam	39	less than 1	1

On the Menahga loamy sand the proportion of conifers is almost 100 per cent, while on the heavier soils, such as Rockwood and Nebish loam, the conifers are practically absent.

The composition of the aspen stands on various soils, as shown in Table 64, shows much the same tendency. Jack and Norway pine are more in evidence on the Menahga and Arago loamy sands; white pine comes in more on the Rockwood sandy loam; while the hardwood species—maple, basswood, etc., are most common on the heavier loam soils.

An examination of the soil map will call attention to the large proportion of the county that is covered by sandy soils. Much of this land which has poor soil for agriculture has distinctly good possibilities for producing jack and Norway pine.

From a forestry standpoint, the Menahga loamy sand and the Arago loamy sand are very favorable prospects. Jack pine or Norway pine do well on these soils. In fully stocked stands they will produce about 27 cords to the acre in 50 years in trees 6 inches d.b.h and

Table 64

Proportion of Species, Aspen Type, on Different Soils

Soil type	Type of stand	Percentage of trees: Aspen	White birch	Maple, basswood, ash, elm, ironwood	Oak	White pine	Jack and Norway pines	Balsam, spruce	Total	Basis, no. of miles of strip
Menahga loamy sand										
3–6	Scattered	73.5	8.5	...	12.5	..	5.5	..	100.0	0.58
6–9	Good	100.0	...	...	...	..	..	..	100.0	0.06
Arago loamy sand										
6–9	Medium	76.0	1.2	...	13.2	2.4	7.2	..	100.0	0.10
9–12	Poor	85.3	14.7	...	...	..	..	..	100.0	0.10
Rockwood sandy loam										
3–6	Good	31.6	49.1	4.0	2.0	13.1	0.2	..	100.0	2.06
	Medium	53.2	30.6	5.0	5.9	1.8	2.9	0.6	100.0	9.16
6–9	Good	60.0	16.4	15.0	7.9	0.4	0.3	..	100.0	1.32
9–12	Good	56.6	1.9	37.3	4.1	..	0.1	..	100.0	0.95
Rockwood loam										
3–6	Good	54.4	28.3	14.8	1.8	0.3	0.1	0.3	100.0	0.98
6–9	Good	64.1	24.3	4.0	4.1	0.1	0.5	2.9	100.0	1.92
9–12	Medium	54.5	1.1	36.5	7.9	..	..	..	100.0	0.12
Nebish loam										
3–6	Good	21.4	52.1	19.0	5.3	2.2	..	..	100.0	0.25

larger. These sandy lands are not easily taken over by brush and weed trees—even aspen does not succeed on this soil, and, consequently, the pines have little competition. Land values are low, and there will be little competition with agriculture. The sandy lands are reasonably level and can be logged at small cost.

Jack pine is not confined entirely to the sandy soils, but has been able to establish itself on some of the heavier soils and even in swamps. The jack pine, however, does not occur in any considerable bodies on the heavier soils because a large share of them have been cleared for agriculture or are preempted by dense stands of aspen and second-growth hardwood.

Jack pine would be expected to grow somewhat faster on some of the heavier soils than on the sands. There is evidence that this is true in site index curves which indicate how tall the dominant trees are at various ages. These site index determinations are not conclusive as to the absolute rating of the different soils on account of the small number of samples obtained on some soils and the rather wide variation in individual samples on certain other soils. They do, however, show some important differences (Table 65).

Just as jack pine is now the characteristic forest tree on the very sandy soils, aspen is the main species on the heavier loams. Aspen occurs upon a wide variety of soils but only under rare conditions does it thrive upon sand, and even where it is able to persist it exists there only as a scrubby tree of poor growth, which will never produce a tree

Table 65

Average Height of Jack Pine at 50 Years On Different Soil Types

Soil type	Average height, feet	Basis, no. of trees
Marquette loamy sand	49	11
Kinghurst loamy sand	51	17
Rockwood loamy sand	52	21
Arago loamy sand	53	38
Menahga loamy sand	56	163
Todd sandy loam	52	30
Rockwood sandy loam	55	36
Marquette sandy loam	56	30
Nebish loam	61	8
Rockwood loam	62	6

of merchantable proportions. On the other hand, on some of the heavier soils, it comes into competition not only with agriculture but with some of the other native hardwoods—maple, birch, and basswood.

Table 66

Average Height of Aspen at 50 Years On Different Soil Types

Soil type	Average height, feet	Basis, no. of trees
Kinghurst loamy sand	48	8
Arago loamy sand	55	7
Rockwood loamy sand	58	14
Sebeka loamy sand	60	6
Marquette sandy loam	59	12
Rockwood sandy loam	65	183
Rockwood loam	60	62
Nebish loam	63	25
Bluffton loam*	75	4
Beltrami silt loam	68	12

* This is a swamp margin soil.

Rockwood sandy loam appears, in general, to be a good aspen soil and will undoubtedly produce cordwood stands in the future. This soil has also produced excellent white pine in the past, but on account of the dense growth of aspen and hazel brush now on the ground it is very difficult for white pine to become established.

There is considerable variation in the productive capacity of the peat soils. Black spruce and tamarack occur throughout the swamp areas but grow most rapidly on the better drained parts of the swamp. Balsam holds to the swamp borders and seldom is found in the center of large swamps. Cedar and ash, likewise, are found only on the better drained shallow peat areas and adjoining mineral soil. Spruce grows faster on well decomposed woody peat than on poorly decomposed sphagnum peat.

MEASURES NECESSARY TO REHABILITATE THE FORESTS

It may be said that there is no commercial sawtimber of any importance in Hubbard County. The actual quantity of commercial pulpwood is also small. There are, however, nearly a half million acres of

potentially productive forest land which with proper treatment and care may produce timber of considerable value in the course of the next 10 to 25 years. A great deal depends upon what kind of care in the form of protection from fire and insects, restraint in cutting, and partial planting, can be given to the lands in the immediate future.

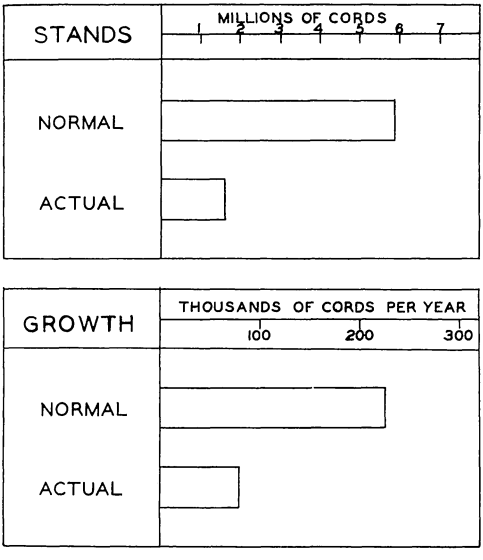

Fig. 55. Comparison of Present Volume and Growth With That Possible Under Intensive Forest Management

It has been shown that the forests, even now, are growing at the rate of over 78,000 cords per year, and this rate of growth might easily be doubled if the stands were allowed to develop without loss from premature cutting and forest fires. Even this rate of growth, however, is not assured if fires continue to run as in the past and all trees are cut as soon as they reach 7 or 8 inches in diameter. Figure 55 compares the present stand of timber and the present rate of growth in Hubbard County with that which might be attained by intensive forest management.

The measures necessary to rehabilitate the forests of Hubbard County vary considerably between forest types.

Pine Forests

In the pine forests, the greatest need is protection from fire, protection from insects and disease, and protection from destructive lumbering. Some planting and other silvicultural treatment is needed. The forest map and the acreage figures show that, as a result of destructive factors, there are 40,000 acres of poorly stocked land in this type. Also, there is far too much jack pine on land which should be growing white and Norway pine. The light sandy soils are among the most productive lands in the county, from a forestry standpoint, and justify fairly intensive management.

Adequate fire protection will help to close up the gaps in the forest and will tend to encourage the re-establishment of white and Norway

pine. This protection must include some system of disposing of logging slash in exposed places and the maintenance of a considerable mileage of fire-line roads where fires are likely to spread rapidly in the grass.

There are relatively few natural enemies of the pines, and these are susceptible of control. The spruce bud worm is damaging and even destroying jack pine in parts of the county. The white-pine blister rust must, of course, be dealt with wherever white pine is to be grown. The white pine weevil and the jack pine sawfly are other enemies which may be expected to inflict losses. Just as with agricultural crops, these things will make reductions in the final crop yield but need not stand in the way of developing the forest. Selective cutting and other silvicultural methods will minimize the losses.

Destructive logging is not a matter for immediate concern for the reason that there is very little logging going on. But, as the present young stands reach merchantable size, there will again be the problem of logging slash and the destructive fires which commonly follow logging. It is to be hoped that the tremendous losses which the county has sustained in the past will not be repeated in the harvesting of the next crop. Some system of regulating logging, slash disposal, and care of fire in logging camps, as well as the regulation of hunting, fishing, and camping on the cut-over areas, will prevent it.

Swamp Forests

The spruce lands suffer less from fires than the pine lands but have been severely damaged by insects in the past. The larch sawfly has practically destroyed all of the older tamarack. The spruce bud worm destroyed a large part of the balsam a few years ago. Proper, selective cutting methods can be effective in combatting such insect outbreaks.

It is an unfortunate fact that a fairly good market for spruce in recent years has lead to the cutting out of a large number of four-, five-, and six-inch trees for pulpwood. Such trees produce only about one stick of pulpwood, and the amount of work in limbing and hauling is greater than with large trees. Furthermore, these trees are at the age when they are making their most rapid growth, and their removal greatly reduces the growth rate of the stand. A selective system of cutting in spruce stands is desirable, but trees of these smaller diameters should be left for further growth.

Hubbard County has no dependable large market for forest products within its boundaries, but there are several pulp mills within a radius of 100 miles. It can count upon a good market to the west

for ties, poles, and posts, and it should have no trouble in marketing rough lumber, box material, lath, etc., to the south and west. In other words, there is ample justification for developing a considerable area of productive forest, particularly in the pine and spruce types.

Aspen and Other Hardwoods

In the aspen and hardwood types the problem is more difficult. Altho much of the land now covered with aspen was originally white-pine land, the pines are now very few and far between. Natural reproduction of pine is tremendously handicapped under the dense aspen and hazel brush which has come in after the burns. Even planting is slow, costly, and not altogether dependable. Wholesale planting with the idea of converting the entire area to pine forest is clearly impracticable. What can be safely recommended is that the aspen land should be given protection from fire, and certain accessible tracts where pine reproduction is getting a start can be thinned out to give the conifers a chance. Some of the better areas can even be developed to produce aspen pulpwood, excelsior bolts, and sawlogs. Certain tracts within the next few years will probably be set aside as game refuges, hunting grounds, and camp sites. For the rest of this large acreage, nothing can be recommended at the present time other than that it be left to recover as best it can. It will have some value for watershed protection, the decaying leaves from the aspen and brush will gradually build up a soil, and a gradual conversion to a better forest type will take place.

FUTURE POSSIBILITIES

The predominence of inferior stands of aspen, oak, maple, and basswood, and the relatively poor condition of most of the pine and spruce lands make the opportunities for private commercial forestry rather limited. Exceptions occur in the case of well-stocked woodlots held in connection with farms and a few tracts of jack pine and spruce of advanced size and good density which can be managed for pulpwood, at least for a few years.

For most of the forest land, some form of public ownership and management seems logical. Such management can assure sustained fire protection, regulation of cutting, and suitable plans for planting or otherwise developing the areas that justify developing. It has been amply demonstrated on the Chippewa National Forest and in Itasca Park, in adjoining counties, that public management can efficiently develop forest properties and thus bring a steady revenue to the communities near which they lie.

VII. RECREATIONAL USES OF LAND

RECREATIONAL VALUES IN HUBBARD COUNTY

The natural beauties of this section were recognized officially when Itasca Park was established in 1891. By 1900 it had become a well-known resort attracting summer visitors, from southern Minnesota and other states, who came not only to see the beauties of lakes crowned with virgin pine, but to enjoy the thrills of splendid fishing. This led to the establishment of commercial summer resorts by men who realized the natural advantages and attractions of this section and the possibilities of making them a source of income. It was the beginning of a new use of land, a new type of production, a new source of income which has until today ranked second only to agriculture as a source of income in the county.

According to the survey of land use, 8,213 acres were dedicated to recreational use. This does not include Itasca Park, which covers 3,804 acres of the county in Lake Alice and Clover townships. The largest part of the area in recreational use is dedicated to use as summer homes. This use involved 4,391 acres or 53 per cent of the total area in recreational use. Commercial resorts use 2,979 acres or 36 per cent of the total recreational area. Farm resorts take up 720 acres or 9 per cent. Golf courses occupy 225 acres or 2 per cent. Present recreational use occupies only about 1 per cent of the area of the county and including that portion of Itasca Park which is in the county, 2 per cent.

The development of the commercial resort business in the county was relatively slow at first. Of the leading resorts now in operation, three resorts were established in 1900, another was started in 1904, and from 1910 to 1920 six additional resorts were established. The decade from 1920 to 1930 saw the greatest development, with 54 new resorts started. During 1930 and 1931, two more were added, making a total of 67 started since 1900. This form of land use should be encouraged in accordance with the demand that may develop.

A total of 54 platted resorts was taken from the courthouse records. They include all types of recreational use, commercial, private, and public or semi-public in character. A total area of 2,579 acres was involved, of which 1,781 acres were platted into lots and 798 acres in outlots. In degree of development, they varied from complete dormancy to 100 per cent activity. Some of them had been vacated and the platted area had been put back into the original government subdivisions. This does not necessarily mean an abandonment of purpose,

but rather a change of type of use, as, for instance, from a commercial purpose to a strictly private use as a summer residence.

A total of 88 resorts within the county were listed at tourist information bureaus. Of these, six were idle when the survey was made. In type, they included strictly commercial resorts in which the resort was the only business; farm resorts in which a farm was operated, either as a sideline of the resort, or a resort operated as a sideline of the farm; groups of individual summer cottages that were rented separately by an individual or company devoting the major part of their time to this business; privately-owned cottages rented purely as a sideline, and finally, summer homes occupied for the greater part of the summer by the owners or their friends. Perhaps camp grounds should be included in this list of types. Outside of those maintained by villages, only one camp ground was found doing no other type of resort business. Many regular resorts and some hotels operated camp grounds in connection. Some of the resorts were started by an individual buying up lakeshore property, subdividing it and selling or leasing it to individuals for private use. Some such colonies are made up of residents from one locality or state.

Another type of recreational use that might be considered partly educational, since they are closely regulated, are the summer camps for boys and girls. Two such resorts or camps for girls were maintained in the northern part of the county and accommodated approximately 150 girls. One camp for boys had recently been established in the central part of the county.

Seventy-one of these resorts were visited and data obtained regarding their operations. Exact records of the number of tourists visiting each resort and the total number of tourist days during the season were not available; consequently estimates of these were obtained. To facilitate the making of these estimates, a schedule was prepared asking for the total capacity of the resort as to guest room, the percentage filled, the average length of stay, and the length of season. From these data estimates of the average number of guests per day and total guest days for the season were obtained. Rates were obtained, permitting a rough approximation of gross income from resorts.

Effort also was made to obtain data on the consumption of agricultural products and the extent to which they were supplied locally, in order to determine the importance of summer resorts as home markets for local products. However, this information was not obtainable in as complete form as desired.

Forty-seven of the resorts visited were classified as commercial, ranging in type from strictly hotel resorts, through combinations of

hotel and housekeeping resorts, to housekeeping only. There were 4 strictly hotel resorts, 10 combination hotel and housekeeping, and 33 had housekeeping cabins only.

Most of the commercial resorts started in a small way with only one cabin for rent. One started with 12, which was the most. The average capacity or guest room at the beginning was 13 per resort. This was increased until in 1930 when the survey was made the hotel capacity was approximately 1,800 or 43 guests per resort reporting. The proportion of capacity reported filled ranged from 15 per cent to 100 per cent, with an average of 46 per cent. The length of season reported ranged from 2 to 3½ months, with an average of 80 days. The average length of stay was 12 days and ranged from one week to one month. Based on these estimates given for each resort, the total number of tourist days was calculated as 83,861 for all the resorts of this type in the county reporting. It is estimated that 1,118 guest rooms were occupied for that total number of days for the county as a whole. In other words, 1,118 tourists lived at commercial resorts for 75 days, the weighted average length of season. They occupied 67 per cent of the total capacity of the resorts for this period. The number of tourist days calculated in a like manner for 1929 was 87,540, indicating a decline of 4 per cent in 1930 from the volume of business in 1929.

The greatest likelihood of error in these estimates lies in the estimated average percentage filled for the entire season.

The rates ranged from $3 to $4 a day per adult, for the hotel resorts, and from $15 to $35 a week for housekeeping cottages, or an average of $21.50 per week or 75 cents per day per individual, estimating an average of four persons per cabin.

People from outside of the state composed 71 per cent of the tourists visiting this type of resort. The range reported extended from 50 to 100 per cent.

Farm Resorts

Nineteen farm resorts were visited and data obtained. Fifteen of them were established between 1920 and 1930. Of 19 reporting, only three started with more than one cabin. The total 20 cabins at first had a total guest room capacity of 88. At the time of the survey in 1930 there were 89 cabins with a total capacity of 404 guests. The per cent of total capacity reported filled ranged from 20 to 100 per cent. The average length of stay varied from two days to two weeks, with an average of nine days. The per cent of guests from outside of the state varied from 25 to 100 per cent, or an average of 77 per cent. The total guest rooms filled for this type of resort was 179 or a total

of 16,313 tourist days. The average length of season was 91 days. The volume of tourists visiting this type of resort amounted to 179 guests for 91 days for the season of 1930.

The rates for individual cabins ranged from $12 to $25 per week for light housekeeping. Sixteen of these resorts had housekeeping cabins only and did not serve meals. Three served meals and also rented cabins equipped for light housekeeping. The average rate with meals was $18.75 per week. Five resorts reported that 100 per cent of their guests came from outside of the state. Others did not report on this point. This type of resort serves as a home market for produce grown on the farm.

Camping Grounds

Fourteen camping grounds were visited. Two of these were public grounds and the others were connected with a resort. The charge made varied from nothing to one dollar per car. The average number of cars reported for 1929 was 82. Five reported kitchens and three more reported camp stoves. All reported wells and tables. Three reported renting boats.

The data secured on camping grounds indicated a definite decline in cars registered and number of visitors in 1930 compared to 1929. Itasca Park camp ground, where accurate records are kept, was a notable exception. The park superintendent reported 3,184 cars registered in 1930, with 11,251 overnight campers, and 2,932 cars registered in 1929, with 10,956 campers. Itasca Park camping ground probably is the most popular camping ground in Minnesota and rightly so because of its natural beauty and interest as well as the accommodations and supervision.

Information regarding summer homes was not secured, because of the expense involved in personal visitation. The number of summer homes was carefully counted from the base maps and checked against the use of land for private summer residence as obtained from township assessors. There were 252 such summer homes outside of resorts included in the commercial and farm resorts. This number includes the individually-owned cottages that are rented by the week, month or season. The season for this type of resort is about two and one-half months.

VIII. TYPES OF LAND OWNERSHIP

Ownership of land in the county was classified according to the following types:

(1) Individual—resident, nonresident; (2) Corporate—land company, timber company, investment and loan company, mining company, water-power company, industrial and railroads; (3) Institutional—educational, religious, fraternal; (4) Recreational—summer resident, corporate resort, individual resort; (5) Public—state, township, village, school, county, Indian, cemetery; (6) Miscellaneous.

The ownership data were obtained from county officials who were familiar with the owners through regular contact through their offices. Residence was defined as actually living on the land, while nonresidence was defined as not living on the land even tho the owner may live in the county and even, perhaps, supervise the use of that land. Summer residence was classified under the general head of recreational ownership. Residents and individual resort owners were included in the resident-ownership class. The item "miscellaneous" includes odds and ends which fit nowhere in particular.

Table 67 summarizes the areas involved in each type in each township. The striking fact shown is that nearly one-half (47 per cent) of the area of the county was owned by nonresident individuals, indicating that the intent of the owner was some use involving personal operation, presumably in agriculture, or investment with hopes of resale, presumably for agricultural use. A large share of this type is represented by tenant-operated farm land.

It is seen from Table 67 that the townships with a high per cent of resident ownership are found in the southern part and northeastern corner of the county where the land is used extensively for agriculture.

The next largest class in point of area was resident, individual ownership. This comprised 24 per cent of the total area of the county, and was made up almost entirely of the owner-operated farm land.

The next largest class was that of corporate timber ownership, 11 per cent of the total area of the county. Corporate land companies owned the next largest share or 7 per cent of the total area. The state was the next largest owner, owning over 3 per cent of the total area. This does not include any land that may be in the process of reversion back to the state through tax delinquency. Investment and loan companies owned nearly 3 per cent, industrial companies and railroad companies owned nearly 2 per cent, and water-power companies owned about 1 per cent. All other types owned less than 1 per cent each.

Table 67

Percentages of Types of Land Ownership in Hubbard County

Township	Individual				Corporate						
	Resident	Non-resident	Individual-owned resort	Summer resident	Land	Timber	Investment and loan	Mining	Water power	Industrial and railway	Corporate-owned resort
Akeley	33.74	37.62	0.96	0.35	0.18	19.91	2.56	....	....	0.54	....
Arago	23.01	57.35	2.41	0.18	12.47	2.66	1.34	....	....	0.39	0.18
Badoura	21.02	48.19	....	0.69	1.59	0.97	2.10	....	....	20.86	....
Clay	7.15	31.04	0.03	0.63	18.31	37.11	0.55	1.66	....	0.36	....
Clover	10.44	50.73	....	0.19	21.56	7.52	1.68	1.09	....	3.29	....
Crow Wing Lake	24.87	35.47	1.24	0.24	1.23	2.45	2.94	....	28.24	....	....
Farden	35.37	48.93	0.70	0.05	2.47	1.41	3.69	0.37	....	0.51	....
Fern	27.82	33.62	....	0.47	17.89	11.30	2.80	....	....	2.51	....
Guthrie	33.27	53.93	....	....	4.54	1.04	4.11	....	....	0.50	....
Hart Lake	38.75	52.59	....	0.54	2.08	....	1.99	0.41	....	0.60	....
Helga	35.13	56.27	0.22	0.27	1.17	0.94	2.68	....	....	0.76	....
Hendrickson	14.28	42.25	....	....	15.36	23.20	2.97	0.35	....	....	....
Henrietta	38.49	49.20	2.76	0.97	3.66	0.17	3.53	....	.0009	0.39	0.05
Hubbard	37.87	55.14	0.23	0.22	0.28	....	2.38	....	....	....	1.19
Lake Alice	4.03	31.98	....	....	23.12	17.24	1.85	....	....	1.09	....
Lake Emma	15.05	42.31	6.42	8.92	5.20	19.31	2.26	....	....	0.12	0.17
Lake George	13.29	48.67	....	.0046	11.03	15.83	4.61	....	....	4.12	....
Lake Hattie	16.63	58.14	....	....	9.41	5.79	2.11	....	....	1.69	....
Lakeport	31.67	46.40	2.06	0.76	4.38	3.39	5.61	0.41	....	0.44	0.42
Mantrap	22.54	48.02	1.63	0.16	6.53	18.67	1.20	....	....	0.87	....
Nevis	32.76	48.40	0.50	4.23	1.47	1.55	1.29	....	4.63	2.26	....
Rockwood	21.36	52.93	1.36	0.23	6.21	8.87	3.01	....	....	3.01	....
Schoolcraft	8.45	51.97	....	....	6.59	13.94	4.99	....	....	0.36	....
Steamboat River District	2.40	42.28	0.17	0.16	5.53	42.25	1.08	....	....	0.62	....
Straight River	41.93	47.80	0.32	....	2.41	0.51	5.03	....	....	0.60	....
Thorpe	7.25	28.11	....	0.50	7.17	50.49	0.36	....	....	0.54	....
Todd	34.59	50.06	0.36	0.29	1.30	0.31	5.82	....	2.21	0.04	0.66
White Oak	37.86	54.62	....	0.08	2.20	2.54	1.40	....	....	0.36	....
County	23.88	46.54	0.70	0.65	7.07	11.21	2.71	0.16	1.14	1.73	0.09

Table 67—Continued

Percentages of Types of Land Ownership in Hubbard County

Township	Institutional			Public						Miscellaneous			Total area, acres
	Educational	Religious	Fraternal	State	Township	School	Indian	County	United States flowage	Village	Cemetery	Miscellaneous	
Akeley	....	0.18	....	1.83	....	....	....	....	....	2.09	0.02	0.0007	21,841.74
Arago	....	....	....	....	....	....	....	....	....	....	0.004	....	20,137.03
Badoura	....	0.71	....	3.85	....	0.01	....	....	....	....	....	0.005	22,818.80
Clay	....	....	....	3.13	0.004	0.009	....	....	....	....	....	0.01	21,927.69
Clover	1.09	....	....	2.40	....	....	....	....	....	....	....	....	21,874.31
Crow Wing Lake	....	....	....	3.32	....	....	....	....	....	....	....	0.0007	19,462.38
Farden	2.22	0.009	....	3.49	....	0.004	....	....	0.35	0.42	....	....	21,605.13
Fern	....	....	....	3.58	....	0.01	....	....	....	....	....	....	22,342.03
Guthrie	....	....	....	2.48	....	....	....	....	....	0.13	....	....	22,589.63
Hart Lake	....	....	....	2.97	....	0.01	....	....	....	....	0.01	0.05	21,635.33
Helga	....	0.74	....	1.67	....	0.01	....	....	....	0.14	....	....	21,532.70
Hendrickson	....	0.004	....	1.57	....	0.01	....	....	....	....	....	....	22,904.97
Henrietta	....	....	....	....	....	0.0047	...	0.38	....	0.10	0.14	0.14	21,008.31
Hubbard	....	....	....	2.22	....	0.0046	....	....	....	0.34	0.05	0.06	21,580.68
Lake Alice	....	....	....	20.63	0.0136	0.02	....	....	....	....	0.02	....	21,971.10
Lake Emma	....	....	....	0.23	....	0.02	....	....	....	....	....	0.0035	17,672.63
Lake George	....	....	....	2.22	0.18	....	....	....	....	0.03	....	....	21,652.68
Lake Hattie	....	....	....	6.12	0.0047	....	....	....	....	....	....	0.09	21,241.29
Lakeport	0.82	0.72	....	2.12	....	....	0.21	....	....	0.38	0.01	0.20	19,472.60
Mantrap	....	....	....	0.37	....	....	....	....	....	....	....	0.0029	20,028.66
Nevis	....	....	....	0.86	....	....	....	....	....	2.05	....	0.0044	18,569.92
Rockwood	....	....	....	3.01	....	0.0047	....	....	....	....	....	....	21,887.05
Schoolcraft	....	....	....	13.69	....	....	....	....	....	....	....	....	21,257.06
Steamboat River District	....	....	....	5.53	....	....	....	....	....	....	....	....	22,392.72
Straight River	....	....	0.71	0.67	....	0.0044	....	....	....	....	0.01	0.0053	22,495.40
Thorpe	....	....	....	5.58	....	....	....	....	....	....	....	....	22,224.35
Todd	....	....	....	0.58	....	0.0048	....	....	....	3.66	....	0.12	27,720.69
White Oak	....	0.0045	....	0.91	....	0.0045	....	....	....	....	0.01	....	22,011.36
County	0.15	0.08	0.03	3.46	0.007	0.0044	0.0067	0.01	0.01	0.32	0.0096	0.02	596,858.24

Total, major types: Individual, 71.77 per cent; corporate, 24.11 per cent; institutional, 0.26 per cent; public, 3.50 per cent; miscellaneous, 0.36 per cent; county, 100 per cent.

Summarizing types of land ownership, individuals owned 72 per cent; corporations owned 24 per cent; institutions—educational, religious, and fraternal, owned ¼ of one per cent; public, 4 per cent, and miscellaneous, a small fraction of one per cent.

The percentages of area owned by corporate timber companies ranged from 50 per cent in Thorpe to 0.17 per cent in Henrietta and none in Hart Lake and Hubbard. The largest percentages were found in Thorpe, Steamboat River, Clay, Hendrickson, Akeley, Lake Emma, Mantrap, Lake Alice, Lake George, Schoolcraft, and Fern townships, in the order named. The range in this group was from 50 per cent in Thorpe to 11 per cent in Fern. All other townships had less than 10 per cent of this type of ownership. It is seen that this type of ownership clustered about the central part of the county in those townships which are relatively lower in percentage of resident ownership. Akeley and Mantrap townships were the only ones of the eighteen highest townships in resident ownership that were included in the eleven highest corporate timber ownership, where they ranked fifth and seventh, respectively.

State ownership was highest in Lake Alice, with 21 per cent, and absent in Arago and Henrietta. The townships having the highest percentage of state-owned land were Lake Alice, Schoolcraft, Lake Hattie, Thorpe, Steamboat River, Badoura, Fern, Farden, Crow Wing, and Clay. The bulk of the state ownership was found in the northern half of the county, and relatively little in the southwestern part where the largest portion of land is in agricultural use.

The largest percentage of land owned by summer residents was found in Lake Emma, with 9 per cent of the area of the township so owned. Six townships had no land ownership of this type. Nevis had the next highest percentage of its area with 4 per cent so owned. All other townships had less than one per cent of their area in such ownership.

Corporate resort ownership was highest in Hubbard, with about 1 per cent of its area so owned. Todd was next with 0.66 per cent. Only four other townships were listed with such ownership: Arago, Henrietta, Lake Emma, and Lakeport.

In individually-owned resorts the percentages ranged from 6 per cent in Lake Emma to none in 12 townships. Following Lake Emma, the seven next highest in order were: Henrietta, Arago, Lakeport, Mantrap, Rockwood, Crow Wing, and Akeley.

Investment and loan companies owned nearly 3 per cent of the area of the county. The range by townships was relatively narrow. The upper limit was 6 per cent in Todd, and the lower limit was 0.36 per

cent in Thorpe. The six townships having the highest percentage of their area in this type of ownership were: Todd, Lakeport, Straight River, Schoolcraft, Lake George, and Guthrie.

Water-power companies owned about one per cent of the area of the county, confined to only four townships: Crow Wing Lake, 28 per cent; Nevis, 5 per cent; Todd, 2 per cent, and Henrietta, a very small amount.

Classifying the type of ownership along broad lines, it is found that over 72 per cent of the area of the county was in individual ownership. About 24 per cent was corporate ownership, and the remaining 4 per cent public, institutional, and miscellaneous.

Table 68

Percentage of Area of Township Owned by Resident-Individual and Nonresident-Individual, with Rank of Each Township for Each Class

Township	Resident-owned		Nonresident-owned	
	Per cent	Rank	Per cent	Rank
Straight River	41.93	1	47.80	18
Hart Lake	38.75	2	52.59	8
Henrietta	38.49	3	49.21	12
Hubbard	37.87	4	55.14	4
White Oak	37.86	5	54.62	5
Farden	35.37	6	48.93	13
Helga	35.13	7	56.27	3
Todd	34.59	8	50.06	11
Akeley	33.74	9	37.62	23
Guthrie	33.27	10	53.93	6
Nevis	32.76	11	48.40	15
Lakeport	31.67	12	46.40	19
Fern	27.82	13	33.62	25
Crow Wing	24.87	14	35.47	24
Arago	23.01	15	57.35	2
Mantrap	22.54	16	48.02	17
Rockwood	21.36	17	52.93	7
Badoura	21.02	18	48.19	16
Lake Hattie	16.63	19	58.14	1
Lake Emma	15.05	20	42.31	20
Hendrickson	14.28	21	42.25	22
Lake George	13.29	22	48.67	14
Clover	10.44	23	50.73	10
Schoolcraft	8.45	24	51.97	9
Thorpe	7.25	25	28.11	28
Clay	7.15	26	31.04	27
Lake Alice	4.03	27	31.98	26
Steamboat River	2.40	28	42.28	21

Figure 56 shows the distribution of types of land ownership. Subdivisions of land are distinctively shaded to indicate type of land ownership. Types of land ownership were not distributed uniformly over the county but varied in amount and suggested some association with land use or soil type. In Table 68 a summary of resident and nonresident ownership is given.

Straight River Township had the highest percentage of its area owned by resident owners. Forty-two per cent of its area was so owned. Next in order was Hart Lake, with 39 per cent so owned. Then came Henrietta, and next Hubbard and White Oak with 38 per cent each.

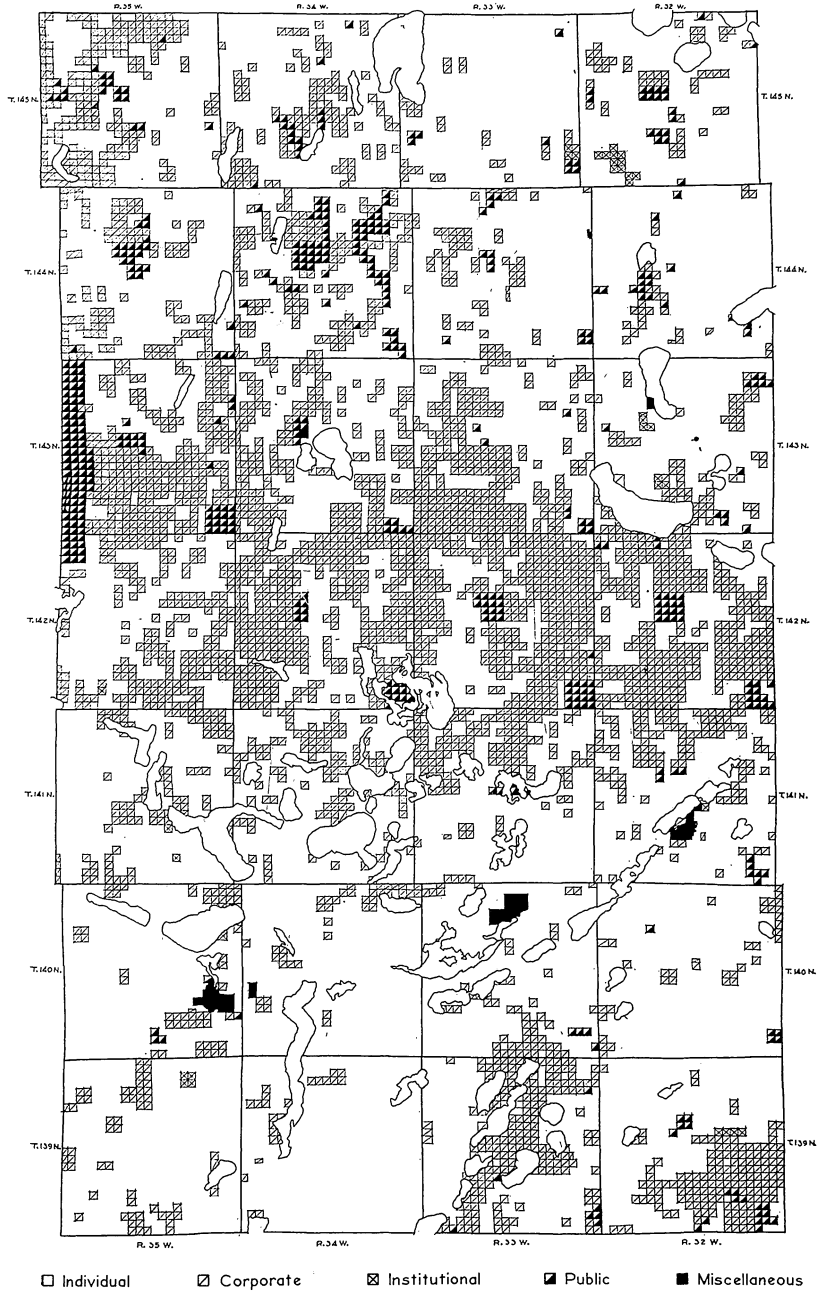

Fig. 56. Types of Land Ownership in Hubbard County

Badoura was eighteenth with 21 per cent so owned. All other townships had less than 20 per cent of their land owned by residents on it.

Nonresident ownership was somewhat differently distributed. The range was from 28 per cent in Thorpe to 58 per cent in Lake Hattie. Hubbard and White Oak were the only two townships having the same rank in both resident and nonresident classes. Lake Hattie ranked nineteenth in percentage of area resident-owned and highest in nonresident ownership.

IX. PUBLIC SERVICES AND IMPROVEMENTS IN HUBBARD COUNTY

SCHOOLS

An economic survey of a county would not be complete without some analysis of the school system and the costs of maintenance, with a comparison, among districts, of unit costs. As a single item of expense, schools usually loom the largest in the disbursement of the funds of a local taxing unit. Of the total taxes levied in the county for 1929 at an approximate rate of 75 mills, an average of approximately 21 mills was levied for school purposes, or 28 per cent of the tax levied. This does not include aid received from the state.

School tax rates in common with rates of other purposes are affected by tax delinquency. As reported by a member of a school board, one district had to levy $3,000 more tax for school purposes in 1930 than in 1929 and an equal increase was in prospect for 1931. They were not spending any more money but were collecting less of the taxes levied.

Figure 57 showing the school districts, was prepared from records at the courthouse. School houses were located from the base map prepared by the road-traverse and cover mappers. The irregularity of the areas belonging to some districts is striking and suggests the possibility of redistricting and consolidating districts into large areas with the aim of economizing without reducing efficiency. The most striking instances are isolated forties, eighties, and quarter-sections, belonging to one school district and entirely surrounded by another district. Long arms from one district project into another district. Natural features, such as lakes and swamps, no doubt explain some of these irregularities, but not all of them. Some are due to transfers made by individual taxpayers, with the sanction of the county commissioners, from one district to another to escape a higher tax rate voted by the majority of a given district.

Some districts with their high daily cost per pupil can attribute that high cost to overbuilding as a result of over-optimism, based on a sincere belief in community growth that did not materalize. Nor is this condition limited to Hubbard County. Northern Minnesota has a number of such school districts. Buildings larger than needed were erected to provide room for the children of settlers who were expected to come to the new country, or in response to temporary development resulting from the location of a saw mill.

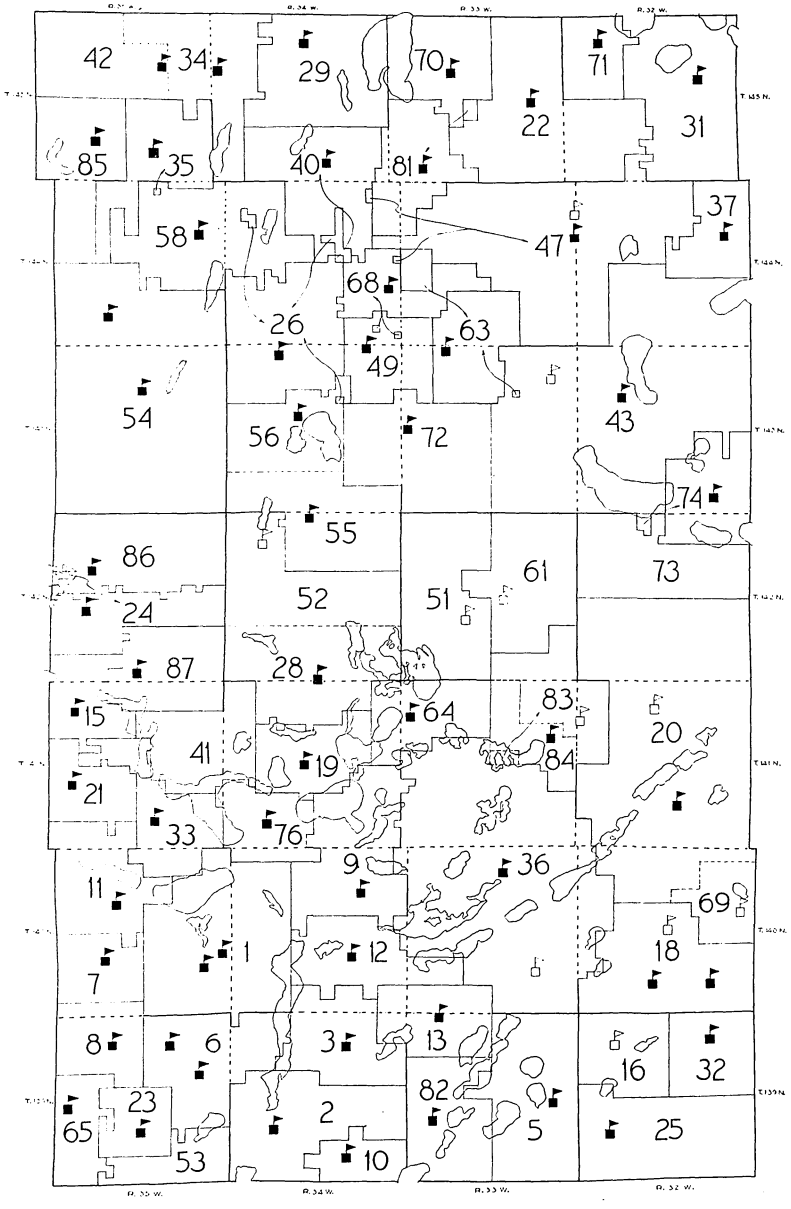

Fig. 57. School District Boundaries and Location of Schools in Hubbard County, 1930

According to the annual school report for the county for 1929-30, 64 school districts operated schools in 70 schoolhouses, employed 123 teachers to teach 2,635 enrolled pupils at a total cost for the year of $217,027.77, of which the local taxing unit paid $123,825.15 or 62 per cent. Two of these districts were independent districts, located at Park Rapids and Akeley. Eight school districts were special or consolidated, located at Hubbard, Dorset, Nary, Farris, Nevis, LaPorte, Guthrie, and Lake Alice. The rest, or 54, were rural school districts. Two districts had no pupils, hence did not operate, and one school sent its pupils to another district. There were thus 51 active districts operating one or more schools.

Table 69 is a summary of the annual school report for the year 1929-30. It also includes total assessed valuation, average value per acre, rate of school taxes, and per cent of delinquency for the 1929 taxes payable in 1930. Table 70 gives the enrollment, attendance, and costs of public schools in Hubbard County in 1929.

The average area of the independent districts was 25,014 acres, with an average assessed value of $546,120.00 and an acre assessed value of $21.83. This acre value ranged from $8.61 in the Akeley district to $53.68 in the Park Rapids district. This wide spread was due to the fact that a large village occupies a larger proportion of the total area of the district.

The average area of the special or consolidated school districts was 20,769 acres. The smallest area was found in the Dorset district, with 8,806 acres, and the largest area in the LaPorte district, with 33,643 acres. The average valuation in these districts was $159,807, with a range from $81,812 in the Farris district to $263,303 in the Nevis district. Four of these districts had a valuation above the average, all of which include villages of some size. One of the four districts below the average in assessed value also included a small village, two included platted village areas that had been vacated, and one was located in a strictly rural district. The acre value ranged from $4.09 in the Lake Alice district to $14.57 in the Dorset district, with an average assessed value of $7.69 per acre.

The total area in rural school districts was 380,691 acres, with an assessed value of $549,083 or an average assessed value of $6.70 per acre. The range in area for rural districts extended from 3,152 acres in District 10 to 12,499 acres in District 58. The assessed valuation ranged from $16,076 in District 84 to $87,735 in District 18. The assessed value per acre ranged from $3.84 in District 73 to $25.66 in District 6.

The rate of taxes varied from one mill in three rural districts to 73.81 mills in the Nevis district. The rates in the two independent dis-

Table 69

Assessed Valuation, School Tax Rates, Tax Delinquency, Receipts and Expenditures of School Districts, 1929-30

District number	Assessed valuation	Average value per acre	Rate of school taxes	Percentage of tax delinquency	Total receipts	Total disbursements
1	787,965	53.68	45.57	10.47	75,454.46	61,045.01
2	176,857	16.71	13.96	31.22	6,311.89	3,712.33
3	101,216	15.31	8.06	16.26	2,360.78	1,162.15
5	50,089	4.81	20.76	24.90	2,724.48	998.31
6	122,835	25.66	8.33	28.39	2,586.36	1,870.04
7	74,450	16.58	11.08	6.16	1,523.78	1,184.86
8	67,740	13.58	13.71	17.31	1,326.79	1,010.98
9	128,342	14.57	26.17	23.32	5,097.07	5,097.07
10	51,522	16.35	16.45	1.41	1,176.65	960.02
11	81,766	11.16	5.91	71.83	1,538.33	911.18
12	94,893	14.44	9.44	17.88	2,138.17	1,103.49
13	44,171	8.59	18.21	41.42	1,836.60	974.72
15	27,372	6.15	34.30	45.59	905.68	765.86
16	31,454	5.91	14.61	28.47	1,727.84	750.82
18	87,735	7.53	25.64	35.70	4,910.31	2,618.76
19	35,427	7.39	17.95	40.85	949.07	880.95
20	304,276	8.61	45.78	40.99	40,049.63	28,330.91
21	28,362	6.42	21.99	28.08	1,455.83	708.92
22	21,572	7.46	65.76	37.70	11,921.74	10,653.45
23	48,032	12.53	13.50	37.51	1,418.65	1,061.96
24	31,846	5.04	26.13	67.89	684.67	534.70
25	54,175	4.58	14.02	37.13	1,670.50	859.52
26	53,847	4.70	13.01	79.67	735.86	623.09
28	51,994	5.15	10.62	48.66	777.54	621.67
29	64,032	6.13	13.50	41.99	1,231.27	849.73
31	81,812	6.64	71.33	42.21	4,147.07	4,070.45
32	30,703	5.41	17.60	34.19	1,491.41	740.58
33	46,148	7.83	50.18	26.01	1,886.29	1,419.47
34	53,910	6.36	11.30	41.67	1,278.56	575.00
35	48,578	6.54	16.44	36.01	1,637.06	983.99
36	263,303	8.93	73.81	43.91	29,380.95	21,358.22
37	34,664	6.60	9.66	18.58	1,643.52	997.17
40	39,610	4.01	31.11	74.00	691.32	574.31
41	30,579	5.11	33.72	56.56	871.19	818.14
42	39,412	5.22	21.82	79.24	789.35	744.56
43	202,084	6.01	64.07	47.94	21,542.62	21,457.88
47	177,652	7.41	23.53	25.00	11,707.73	11,477.43
49	28,297	5.35	29.28	45.18	1,402.66	788.95
51	59,067	5.85	21.33	75.69	1,262.00	1,063.78
52	49,436	4.90	11.12	75.10	672.26	523.30
53	29,020	7.75	38.00	53.31	651.93	574.20
54	126,837	4.09	32.54	66.85	3,790.73	3,478.71
55	48,674	4.75	19.19	48.86	749.52	501.99
56	33,839	5.54	34.26	56.94	1,234.44	1,039.82
58	59,166	4.73	21.29	53.77	1,171.26	987.11
61	37,009	3.87	1.00	94.84	.....	.....
62	47,622	6.24	21.19	42.56	1,151.80	1,071.63
64	29,303	6.15	1.00	40.62	1,294.33	910.67
65	52,264	12.23	8.67	42.72	1,601.57	807.82
68	27,270	5.41	26.86	65.33	825.65	712.40
69	21,316	5.16	33.68	43.13	1,586.36	599.65
70	44,315	7.82	16.81	10.48	1,462.32	1,069.71
71	27,817	7.04	8.20	24.76	2,200.00	811.66
72	58,628	5.04	14.66	74.53	380.47	346.29
73	35,567	3.84	1.00	71.35	1,655.59	28.00
74	30,393	4.97	24.04	40.60	1,212.29	831.13
76	36,905	8.73	24.04	11.17	1,587.89	1,261.35
81	39,294	5.62	44.80	55.42	1,666.45	879.57
82	55,916	8.22	22.41	8.94	1,641.40	1,209.00
83	26,499	4.08	53.39	85.06	425.04	378.80
84	16,076	4.53	42.21	50.61	1,911.89	712.10
85	45,189	5.82	50.21	73.77	945.64	866.27
86	48,679	5.05	30.73	71.55	826.32	792.23
87	34,960	5.15	34.16	71.99	472.89	273.93
County	4,919,783	8.24	....	36.81	283,363.72	217,027.77

Table 70

Enrollment, Attendance and Costs, 1929

District number	Enrollment	Average daily attendance	Total days of school	Average daily cost per pupil	
				To state	To local unit
1	795	655	180	$0.20	$0.32
2	70	56	180	0.17	0.20
3	29	22	180	0.10	0.21
5	19	13	180	0.15	0.24
6	27	13	175	0.19	0.56
7	18	15	180	0.15	0.27
8	19	12	180	0.19	0.26
9	46	44	180	0.30	0.33
10	19	14	180	0.12	0.24
11	24	14	180	0.15	0.19
12	17	15	180	0.09	0.31
13	14	6	180	0.22	0.56
15	10	8	160	0.11	0.49
16	17	13	160	0.15	0.20
18	43	32	160	0.14	0.44
19	12	12	160	0.09	0.39
20	284	245	180	0.31	0.33
21	12	6	160	0.17	0.45
22	90	72	180	0.42	0.40
23	18	10	180	0.19	0.40
24	12	6	160	0.24	0.31
25	33	27	160	0.09	0.10
26	26	14	180	0.13	0.11
28	13	7	160	0.19	0.35
29	23	16	160	0.07	0.26
31	19	16	170	0.40	1.10
32	10	7	160	0.25	0.40
33	22	16	180	0.10	0.39
34	9	7	160	0.14	0.32
35	20	13	180	0.13	0.27
36	219	186	180	0.08	0.56
37	19	12	160	0.21	0.28
40	14	11	160	0.15	0.20
41	5	4	160	0.23	0.80
42	9	7	160	0.24	0.41
43	179	151	180	0.39	0.40
47	136	117	160	0.33	0.21
49	11	8	160	0.17	0.39
51	12	11	180	0.10	0.43
52	3	2	160	0.78	0.52
53	15	13	160	0.09	0.19
54	33	25	180	0.27	0.52
55	4	3	170	0.20	0.55
56	17	13	170	0.32	0.14
58	24	15	180	0.09	0.24
61	...	...	...	...	...
63	12	10	180	0.22	0.32
64	4	3	160	1.26	0.62
65	22	15	160	0.13	0.21
68	12	6	160	0.24	0.42
69	...	...	...	...	...
70	12	10	180	0.15	0.45
71	11	9	160	0.20	0.39
72	9	5	160	0.10	0.27
73	...	...	...	...	...
74	14	8	180	0.17	0.35
76	4	3	160	0.30	2.03
81	9	7	160	0.15	0.54
82	11	8	180	0.15	0.59
83	...	...	...	...	...
84	5	3	160	0.63	0.66
85	14	10	160	0.12	0.40
86	19	12	160	0.17	0.24
87	7	6	140	0.12	0.20
.....	2,635	...	10,145	$0.22	$0.36

tricts were 45.57 mills for the Park Rapids district and 45.78 mills for the Akeley district. In the special school districts the school tax rate ranged from 13.96 mills in the Hubbard district to 73.81 mills in Nevis. The average school tax rate for these special districts was 46.39 mills. Four had rates higher than the average and four had rates lower than this average.

Among rural schools the school tax rate ranged from one mill tax in two districts (Nos. 63 and 73), in which the schools had been closed on account of a lack of pupils, to 53.39 mills in District 83. The pupils from this district attended school in District 84. The bulk of the taxes raised in the closed district were used to retire $6,500 in bonded indebtedness.

The average percentage of delinquent taxes for 1929 payable in 1930 by school district areas was 36.81. The range extended from 1.41 per cent in District 10 to 94.84 per cent in District 61, which maintained no school at the time. Only 20 districts had a delinquency percentage of less than the average. For the independent districts the percentage of delinquency was 10.47 for the Park Rapids district and 40.99 per cent for the Akeley district. The delinquency in special districts ranged from 23.32 per cent in Dorset to 66.85 per cent in the Lake Alice district. The widest range was found in rural school districts and was the same as the range for all districts of the county. The high delinquency percentages were found in the central part of the county extending to the extreme northwest corner and to the western edge. District 11 in Arago likewise had a high delinquency percentage. In general, high delinquency and high school tax rates were associated.

Total disbursements by districts varied with the size of the school in terms of pupils, teachers, and plant necessary, and the relative cost of these items. For the year 1929-30 a total of $217,027.77 was spent in the schools of the county. The independent districts expended the largest sums because of the size of their schools. The Park Rapids district expended $61,045.01 for the year and the Akeley district spent $28,370.91. The special school districts varied in their expenditures from $3,478.70 in the Lake Alice district to $21,457.88 in the Lakeport district. The rural schools varied in their expenditure from $28.00 in District 73 to $2,618.76 in District 18. District 73 maintained no school and had accumulated a fund in cash on hand at the end of the year of $1,637.59 and was levying only a one mill tax. District 18 maintained three schools.

Based on current receipts from local units and from the state, the local unit contributed 62 per cent of total cost while the state contributed 38 per cent. This proportion was not uniform for all districts,

however, depending on the amount of state aid and apportionment each district received. The percentage received from the state by districts ranged from 13 per cent in District 76 to 61 per cent in the Guthrie district. The percentage contributed to the independent districts was 39 per cent in the Park Rapids district and 49 per cent in the Akeley district. Special districts obtained aid from the state for 1929-30 ranging from 13 per cent of total disbursements in the Nevis district to 61 per cent in the Guthrie district. The average percentage of total costs received from the state was 41. Three schools received less than the average and five received more. The state's contribution to the expense of operating rural schools varied from 13 per cent in District 76 to 70 per cent in District 56.

The total number of pupils enrolled in all of the schools of the county was 2,635. The highest enrollment was found in the independent districts. Park Rapids had a total enrollment of 795 pupils and an average daily attendance of 655. Akeley had a total enrollment of 284 and an average daily attendance of 245. The special districts had an enrollment ranging from 19 in the Farris district to 219 in the Nevis district, with a daily attendance varying from 16 in the Farris district to 186 in the Nevis district. The rural schools had an enrollment varying from 3 pupils in District 52 to 43 enrolled in District 18. The average daily attendance in District 52 was 2 and in District 18, where 3 schools were maintained, it was 32. The highest average daily attendance in a single rural school was 27 pupils out of a total enrollment of 33 in District 25, a record that equalled that of one special district. Excluding the independent and special districts, the average enrollment for the 54 rural schools of the county was 16, with an average daily attendance of 10. Thirty-three schools had an enrollment of less than the average, and 29 had an average daily attendance of 10 or less.

The enrollment per square mile of area for all districts, indicating density of school population, was 2.83, and the average daily attendance was 2.22. The enrollment per square mile varied from 0.19 in District 52 to 34.66 in the Park Rapids district. The enrollment per square mile for the special districts varied from 0.68 in the Lake Alice district to 4.75 in the Nevis district. The average daily attendance per square mile varied from 0.52 in the Lake Alice district to 4.04 in the Nevis district. Excluding the independent and special districts, the enrollment per square mile varied from 0.19 in District 52 to 3.86 in District 10, in Hubbard township. This represents a wide range in density of school population and suggests schools operated for few pupils at a high pupil-day cost.

The total number of school days varied from 140 in District 87 to 180 in 26 districts. Both of the independent districts maintained school for the full 180 days; six special districts did likewise, while one special district kept school for 170 days, and one for 160 days. Eighteen rural schools kept school for 180 days, one for 175 days, 2 for 170 days, 29 for 160 days, and one for 140 days, or an average of 169 days.

The total attendance in days for all schools of the county was 375,418. The highest attendance in days was in the Park Rapids district, with 117,905, and Akeley next, with 44,219. Among the special districts the total attendance in days varied from 4,430 in the Lake Alice district to 33,577 in the Nevis district. Among the rural schools the total attendance varied from 551 in District 84 to 4,513 in District 18, with three schools, and 3,808 total attendance in District 3.

The average cost per pupil day is perhaps the most significant single fact in regard to schools since practically all other facts and conditions contribute to this one cost.

The total operation cost includes building and equipment expense, maintenance of plant, teachers' salaries, supplies, etc. Some of these are fixed, while some are proportional to the enrollment and daily attendance. Likewise, there is a minimum total expense in keeping with the school standards established by the state. With a given cost, the cost per pupil day varies inversely with the total attendance in days, which is dependent on enrollment, days of school, and average daily attendance. Hence, average cost per pupil day is the most significant index of the condition of the school district in that it is the best measure of financial efficiency in school operation. Low cost does not necessarily mean low standards, but frequently means the reverse. Low pupil-day cost is the goal in education, given standards considered, as is low unit cost in production. Large school population, density, high enrollment, or, more especially, high average daily attendance, i.e. volume, is the main determinant of unit cost standards and quality considered. This does not mean that low cost regardless of quality of training should be striven for. Highest value for money expended must be considered.

The total annual cost of operating schools in the county is divided by the total attendance in days for the county as a whole. This gives the average cost per day for one pupil, or briefly the average pupil-day cost. Similarly, the pupil-day cost is calculated for each school district.

The average pupil-day cost for all schools in the county was 58 cents. Of this cost, the state paid 22 cents and the local school district paid 36 cents; or, expressed in per cent, the state paid 37.96 per cent and the local district paid 62.04 per cent, as an average for all schools.

The range in pupil-day cost was from 19 cents in District 25 to $2.33

in District 76. This indicates a wide variation in the economic factors affecting schools in the county.

The pupil-day cost in the two independent districts was 52 cents and 64 cents for the Park Rapids and Akeley districts, respectively. In the Park Rapids district the state contributed 20 cents per day and the local district paid 32 cents, or, on the percentage basis, the state paid 39 per cent and the local unit paid 61 per cent. In the Akeley district the state contributed 31 cents per pupil per day and the local unit paid 33 cents. On a percentage basis, the state paid 49 per cent of the school cost and the local unit paid 51 per cent.

Among the special districts, the pupil-day cost varied from 37 cents in the Hubbard district to $1.50 in the Farris district. The second highest in this group was the Nary district, with 82 cents per pupil-day cost. The proportions paid by the state and the local unit also varied widely. In the district at the lower limit, 17 cents per pupil day was paid by the state and 20 cents by the local unit, or 47 and 53 per cent, respectively. In the Dorset district the proportions were about the same, being 48 per cent by the state and 52 per cent by the local unit. In the Nary district the proportions were reversed, 52 per cent being paid by the state and 48 by the local unit. In the Farris district in which the pupil-day cost was $1.50, the state paid 40 cents and the local unit paid $1.10, or 27 and 73 per cent, respectively. It seems that when the pupil-day cost is high, the local unit pays a large proportion of it, causing the local taxes to be high and thus encouraging increased delinquency, which aggravates the situation still further. In the Guthrie district, the state contributed 33 cents toward a total pupil-day cost of 54 cents, or 61 per cent. In the Lake Alice district the state paid 27 cents of the total pupil-day cost of 79 cents, or 34 per cent. There was evidently a wide range in percentages contributed by the state to pupil-day cost.

In the rural school districts, the pupil-day cost ranged from 19 cents in District 25 to $2.33 in District 76. The extremely high cost in the latter district was due to an expenditure of $1,261.35 for an enrollment of four pupils and an average daily attendance of only three. Of this total cost, the state paid 30 cents while the local unit paid $2.03, or 13 and 87 per cent, respectively. District 64 had a pupil-day cost of $1.88, of which the state paid $1.26 and the local unit 62 cents, or 67 and 33 per cent, respectively. The high cost here again was due to few pupils, the total enrollment being four, with an average daily attendance of three. District 52 had a pupil-day cost of $1.30, of which the state paid 78 cents and the local unit 52 cents, or 60 and 40 per cent, respectively. Here also the enrollment was low, being three with an average attendance of only two. The lowest pupil-day cost of 19 cents

was due largely to a relatively high enrollment of 33 and average daily attendance of 27, and also to a relatively low total disbursement of $859.52. The next lowest cost of 24 cents per pupil day was in District 26, where the enrollment was 26, average daily attendance 14, and total expenditure $623.09. High pupil-day costs were due in a large measure to low enrollment and daily attendance, combined with building and equipment cost low in proportion to daily attendance. In all of the five rural schools in which the pupil-day cost was above one dollar, the total enrollment was less than five and the average daily attendance three or less. The large proportion of districts below the average in enrollment and daily attendance suggests the need of further detailed study of this situation. Eighteen school districts had a total bonded indebtedness of $187,660. The Park Rapids district had a bonded debt of $83,200, due to the recently constructed addition to the high school building. Akeley had no bonded debt. Among the special districts the bonded debt ranged from $4,000 in Hubbard to $34,000 in Nevis. Five of these special districts had a bonded debt. Among the rural schools, 12 districts had bonded indebtedness ranging from $600 in District 51 to $6,500 in District 83. In eight of these the enrollment and average daily attendance was less than the average for all rural schools. The district with the highest bonded debt had too few pupils to operate a school and sent them to a neighboring district. This indicated difficulty in collecting sufficient taxes to make payment of the debt possible. Doubtless these bonds were voted when there were more settlers and a larger school population, but the fact remains that this bonded debt is saddled on relatively few taxpayers.

Eleven school districts had outstanding warrants amounting to $8,762.71, ranging from $75.00 in District 42 to $3,871.81 in the Farris district. Five of the ten rural districts included had less than the average enrollment and daily attendance.

High pupil-day cost, bonded debt, and outstanding warrants were definitely associated with low enrollment and daily attendance. Not only does this reduce the absolute amount and proportionate share paid by the state, but it also indicates relatively few resident taxpayers who have children of school age. It indicates sparce rural population and limited agricultural development and low tax revenue. This sparseness of population may be due to lack of initial development, or abandonment and emigration. It presents a problem in school organization or reorganization that must be studied, and some remedy must be evolved.

Since the survey was completed, the county superintendent of schools and the State Department of Education have studied the problem of the cost of public instruction in Hubbard County, and certain recommendations to economize in school costs have been made.

RURAL TELEPHONE LINES

The data on rural telephones were secured from the managers of exchanges, owners of private lines, and secretaries of mutual telephone companies. The data in most cases were taken from the reports made in 1929 to the Minnesota Railroad and Warehouse Commission. Maps were drawn showing the location of the lines, and from these the mileage in the various townships was determined as accurately as possible.

There were 38 companies operating rural telephone lines in the county. Nineteen of them were incorporated; 30 were mutual stock companies; 3 were township systems; 3 were copartnership associations; one was a stock company, and one was a private line. The stock company operated 10 rural lines; one mutual operated 3 lines; three mutuals operated 2 lines each; and the rest operated one line each. They owned 640 miles of line and 895 miles of wire, or an average of 17 miles of line and 25 miles of wire per company. They operated 54 lines on an average length of line of 12 miles and an average of 17 miles of wire. They served 753 telephones, or an average of 14 telephones per line. The shortest line owned by any company was 1½ miles, and the longest 75 miles. Non-metallic or grounded lines were used on 53 lines, with only 27 miles of metallic line in all. Twenty-four companies reported selling 903 shares of stock at an average value of $23.35. Fifteen companies reported making annual assessments averaging $3.80 per member telephone, and five reported non-member assessments of $8 for each telephone. The telephone instruments and batteries were owned by the members in 33 companies, while two companies owned the instruments. The townships bought and owned the instruments in the township systems.

The cost of constructing the lines varied from $20 to $3,669.26, with an average of $38.98 per mile of line owned. The cost per mile ranged from $3.78 to $117.64. This wide range was due to the difference in method of construction. In the case of the low-cost line, the members built their own line, furnished poles, and bought only wire and insulators, whereas for the high-cost line all material and labor were paid for. The three townships built their lines at an average cost varying from $35.67 to $61.76 per mile.

The lines were maintained mostly by the members themselves, without any close supervision of the condition of the lines, apparently with satisfactory results and at a low maintenance cost.

Thirty-five companies paid a fixed switching or exchange charge per telephone to a central exchange. These rates varied from $3.60 to $6.00 per telephone, with an average of $4.24. Two companies paid toll charges varying from 5 to 15 cents for each exchange connection. The

total expense per company per year varied from $54.59 to $774.46. This included switching or exchange charges which were collected by the company from its members and paid to the exchange. The average annual cost per telephone was $12.74 and varied from $4.20 to $28.42. The low cost included only switching charge, while the high cost perhaps included long distance calls which were collected by the company. The high-cost line served a large summer colony. The average cost does not include batteries and repairs made on the line. The most common cost was approximately $6.50 per telephone per year. Two townships reporting annual expense showed an average cost per telephone per year of $5.16 and $6.76. This would appear to be a lower cost than the average mutual companies, with the exception of those in which the members maintain their own lines. The townships, however, furnished the instruments so that the patron did not need to invest in one of his own. The cost and maintenance of those township lines were paid by a levy of 2 to 4 mills in taxes.

The total number of miles of wire operated in the county by the rural telephone companies was 668. The total number of patrons in the county was 762, or an average of 0.84 miles of wire per patron. The number of miles of wire per patron ranged from 0.5 of one mile to 2.78 miles, with an average of 1.18.

The mileage of rural telephone wire in the county was distributed in every township except Steamboat River. The range in number of miles varied from 6 to 76, with an average of 24. Twenty of the townships had less than the average mileage, and eight had more than the average.

RURAL FREE DELIVERY

The data on rural routes were obtained from the postmaster and rural mail carriers. Maps were prepared from the blueprints of mail routes at the post office and, if not available there, from the mail carriers themselves. The miles of mail routes per township were estimated from the route maps. The number of patrons within the county on routes that lie partly outside of the county was obtained by calculating the average number of patrons for the route as a whole and then applying that average to the number of miles of route in the county. These data necessarily are only approximate.

Hubbard County had 22 mail routes delivering mail to 1,375 patrons over 618 miles of roads daily except Sunday. Eighteen of these routes were regular rural free delivery routes and four were star routes that not only serve patrons along the way but may serve an inland post office and haul supplies and passengers. The average length of the rural routes was 31 miles, with an average of 73 patrons per route.

Park Rapids had three rural routes and four star routes serving Hubbard, Niawa, Itasca Park, and Osage. The Osage route, however, served no patrons in the county. Akeley, Nevis, Guthrie, and Hubbard each had two rural routes. Akeley had three which were consolidated into two in 1930. La Porte had one rural route and a star route that served Yola and Fern Hill post offices besides 115 patrons along 65 miles of road. Fern Hill Post Office served 3 patrons and Yola served 10. Bemidji Post Office in Beltrami County sent two rural routes and one star route into the county serving 153 patrons along 50 miles of road within the county. It also served Becida Post Office, which had a rural mail route of 27 miles serving 82 patrons. Menahga sent a route into Straight River Township which served 34 patrons on 16 miles of route.

The first rural route was established from Hubbard Post Office in 1895. The star route to Osage was established in 1892 from Park Rapids. Two routes, one rural and one star, were established from Park Rapids in 1900; another rural route from Park Rapids in 1904; a star route from Hubbard in 1905; a star route from Park Rapids to Niawa in 1910; two rural routes rom Nevis in 1914; a star route from Bemidji to Becida in 1915; another rural route from Park Rapids and one from Akeley in 1916; a rural route from Bemidji and one from La Porte in 1917; the first rural route from Guthrie in 1922; a second route from Hubbard in 1923; two rural routes, one from Bemidji and one from Guthrie, in 1924; a route from Akeley in 1926, and a route from Becida in 1928.

An attempt was made to secure data on the trend of changes in the number of patrons over a period of years. Nevis Post Office reported the same number of patrons as when the two routes were organized. Guthrie reported the same number of patrons on one route and a decrease on the other. La Porte reported an increase from 72 to 90 since Route 1 was organized. Hubbard reported a decrease from about 100 patrons on Route 2 in 1923 to 69 in 1929. No data were secured from other routes.

The routes from Bemidji had the largest number of patrons per mile, 3.19 for one route and 3.16 for the other. Nine of the 21 routes had more than the average of 2.23 patrons per mile.

The average number of miles of mail routes per township was 22. Steamboat River had no mail routes, while Henrietta had 39 miles, Hubbard 39, and Akeley 35. Fifteen townships had less than the average number of miles of mail route, and 13 had more than the average. Townships with smallest mail route mileage were Clover with 5 miles, Clay, 6, and Thorpe 8.

X. TAXATION OF LAND IN HUBBARD COUNTY

The records of taxation for the earlier years of the county are incomplete. The only data that are fairly complete and dependable back to 1884 deal with delinquency on real estate, total value of all property, and acreage on the tax list outside of platted areas. The data are believed to be sufficiently accurate to show general trends or changes. The data for the county as a whole were built up by a summation of the various items taken from each township record. The township records were used in an endeavor to refine the analysis from the county basis to smaller areas which would permit association of economic data with general soil and cover types and land use.

TAXABLE LAND

The area of the county appearing on the tax list gradually increased as more of the land passed into private ownership and thus became subject to taxation. To get as clear a picture as possible of the development of this private domain, tax records were studied back to 1884 and data taken at two-year intervals, selecting the years when land assessments were made. Table 71 shows the acreage and percentage of the total land area of the county by two-year periods. In 1886, 94,127 acres, or 29.7 per cent of the present area of the county, were subject to taxes. Between 1894 and 1896 the taxable area increased rapidly from 194,054 acres to 359,328 acres. This is the greatest gain made for any two-year period. This is explained by the fact that 12 additional townships were added to the county in 1895. The availability of homestead land and the economic depression may be further explanation. From this time on, the taxable area increased steadily, reaching the highest point in 1926 when 579,982 acres, or 97 per cent of the area of the county, were taxed. Since that time there has been a slight decline. The percentage in private ownership will continue to decline rather than increase if delinquency continues to increase and land reverts to public ownership. If the land yields little or no immediate income, with little or no prospect of early sale, with future income remote and uncertain, taxes will become delinquent and land will revert to public ownership. If taxes are levied out of proportion to the income derived from the use of land, i.e., when land ceases to be self-supporting as far as taxes are concerned—to say nothing of paying a reasonable rate of interest on the investment, the taxes will become delinquent. This

is especially true of large holdings, on which the taxes involve relatively large sums of money. The small land owner may continue to pay taxes on idle land from other income for a longer time. Furthermore, as more land reverts to public ownership, a smaller area is left to bear the burden of taxation. The total tax burden remaining the same, the share incident to a given tax-paying area or individual owner grows heavier and more burdensome for those remaining as tax delinquency increases.

Hubbard was chosen as a typical township of the prairie group. It was the first township to have settlers, but was not an independent township until 1888. As early as 1888 it had 14,493 acres on the tax list because, being prairie, its area was relatively easy to develop. In 1900 it had 21,000 acres taxable and has maintained its acreage above that to the present time. It reached its peak in 1916 with 21,500 acres taxable, maintained that amount into 1924, and has declined slightly since. Its taxable acreage in 1930 was 21,258.

Straight River had 10,867 acres on the tax list in 1888, reached 21,000 acres taxable in 1904 and its peak of 22,643 acres in 1916, and declined slightly to 22,202 in 1930. The townships in this part of the county had practically all their land on the tax lists soon after 1900 and have kept it there with little change since.

Table 71

Acreage on Tax List for Hubbard County

Year	Acres	Percentage of total	Year	Acres	Percentage of total
1886.....	94,127.00	29.7	1910.....	543,204.00	91.0
1888.....	142,770.00	44.6	1912.....	554,025.00	92.8
1890.....	154,243.00	48.2	1914.....	562,608.00	94.3
1892.....	185,758.00	58.3	1916.....	569,712.00	95.5
1894.....	194,054.00	60.6	1918.....	576,873.00	96.7
1896.....	359,328.00*	60.2	1920.....	579,375.00	97.1
1898.....	385,532.00	64.6	1922.....	578,057.00	96.9
1900.....	403,175.00	67.6	1924.....	579,184.00	97.1
1902.....	416,629.00	69.8	1926.....	579,982.19	97.2
1904.....	465,506.00	78.0	1928.....	572,006.00	95.9
1906.....	494,322.00	82.8	1930.....	572,621.29	96.0
1908.....	518,969.00	87.0			

* Area of county increased by the addition of 12 townships.

Thorpe Township is typical of the central area of the county. Its taxable acreage rose from 7,241 acres in 1886 to 14,815 in 1888, remained at that level for 10 years, and then steadily increased to 1914, when it had 21,015 acres taxable, and has retained that level since. Steamboat River has a similar history, but shows a definite decline since 1920. This also applies to Clay, Clover, Lake George, Lake Alice, Arago, Lake Emma, and Mantrap townships.

Hart Lake had 9,006 taxable acres in 1896, increased from 9,690 in 1902 to 13,532 in 1904, and then steadily increased until 1920, when it had 21,059 acres. It has maintained this amount practically unchanged

since. A similar situation is found in Guthrie, Farden, and Helga townships.

Too much weight must not be placed on apparent sudden changes in taxable area, as land does not go on or off tax rolls suddenly. Some sudden breaks reported in taxable area may be attributed to errors in the records.

VALUATION[1]

The total value of all general property in the county returned by the assessors as taxable increased from $405,182 in 1886 to $4,780,118 in 1930. The value of all property includes real estate and personal property subject to tax, but does not include moneys and credits. Figure 58 shows the equalized assessed valuations of lands and buildings in Hubbard County.

The assessed value of all property increased rather steadily with the exception of the years 1906 and 1920, when the rise was sharp, followed by an abrupt decline. The sharp rise from 1918 to 1920 is a reflection of the post-war inflation and the land boom. The decline since 1920 is in turn due to the post-war deflation and the general decline in agricultural values. It appears that the valuation in villages has been steadily increasing proportionately, except since 1920, when the valuation in villages has increased relatively more. This may be explained by the fact that prior to its incorporation as a village in 1916, Akeley was included in the township. The other villages, with the exception of Park Rapids which started almost as soon as the county was organized, were likewise included in the township in which they were located prior to their incorporation and after their dissolution. Hence, any generalization as to proportionate valuation of strictly rural areas and villages cannot be made accurately.

The trend of valuation changes of the different townships shows marked variations. They may be arranged or grouped according to similarities, which are suggestive of the variation in probable true value among the different townships.

The four townships of Hubbard, Straight River, Todd, and Henrietta are markedly similar with respect to changes in assessed valuation. They all show a relatively steady increase in assessed value since their organization and have reached the highest total valuation among the townships in the county. Hubbard had the highest valuation, $333,624 in 1928 and $314,686 in 1930; Henrietta was next, with $295,887

[1] The value figures here used are the assessed values used for taxation purposes and not the true and full value. Prior to the enactment of the classified assessment law in 1913, assessors were expected to assess property at its full value but in practice did not. The law of 1913 set up a classification of property and provided that assessed values should be a certain percentage of the true and full value. Unplatted real estate is assessed at 33⅓ per cent of its true and full value. The true and full value in 1930 consequently would be about 14 million dollars.

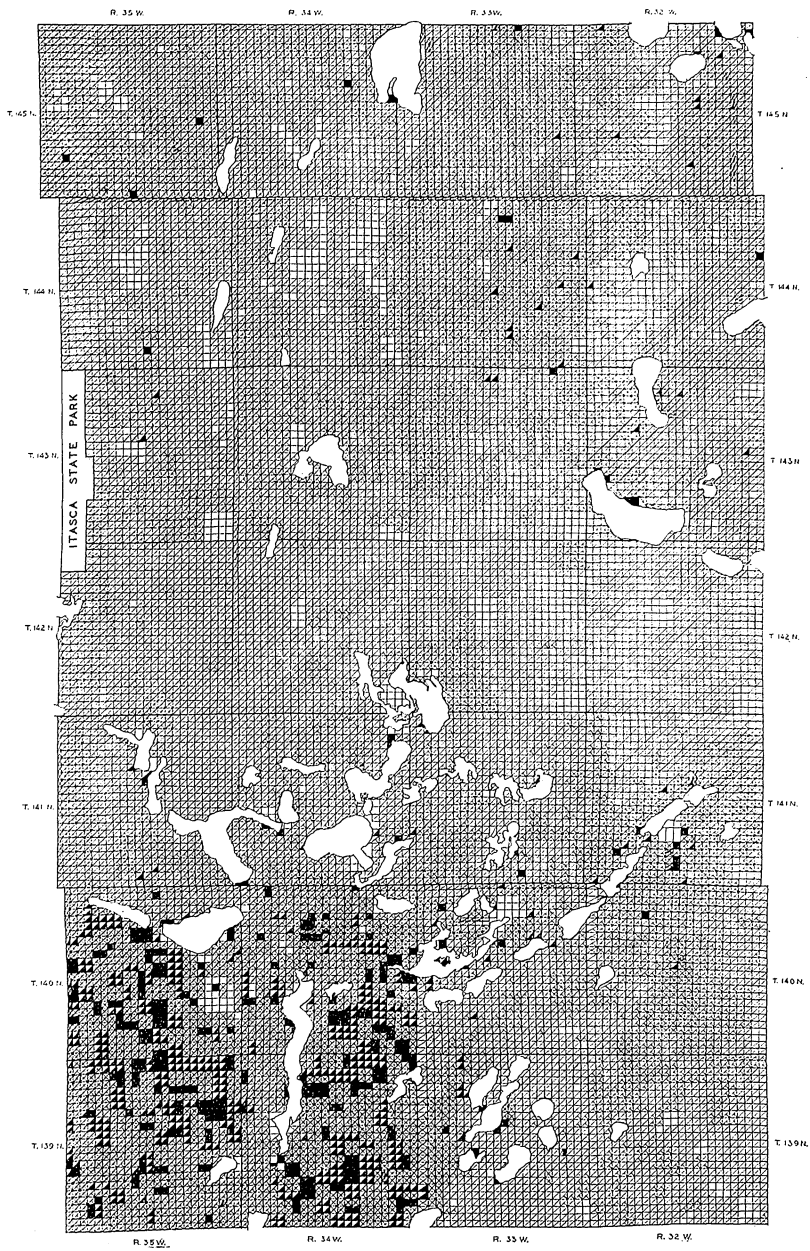

Fig. 58. The Equalized Assessed Valuations of Lands and Buildings in Hubbard County

and $269,098; Straight River, $273,441 and $269, 702, and Todd, exclusive of the village of Park Rapids, $266,984 and $253,234. Straight River had only a slight decline from 1921 to 1930. The other three townships have seen definite decline in the last decade.

Helga and Guthrie are likewise similar in their growth in valuation and rank next as a group in total assessed valuation, with $156,782 and $158,118, and $169,942 and $170,977, respectively, for 1928 and 1930. Both have shown a steady increase.

Akeley, Nevis, and White Oak constitute another similar group. Data on Akeley Township exclusive of the village are not available prior to 1916. Since that time, however, its valuation has paralleled the other two neighboring townships closely. All three reached their peak of valuation in 1920, with a decline following, the reasons being the same as those given for a like condition in the county. Their valuation has been well maintained during the last eight years. The 1930 valuations were $145,480 for Akeley, $145,730 for Nevis, and $154,548 for White Oak.

Another group is composed of Hart Lake, Farden, Rockwood, Lakeport, and Fern. All increased steadily from a relatively low value in about 1900 to the peak in 1920; declined, but recovered what they lost, up to 1928, except Lakeport and Hart Lake which are still slightly below their valuation of 1920. Hart Lake, Farden, and Rockwood showed a decline in 1910 due, no doubt, to the cutting of the limited amount of timber included in the value prior to that time. Lakeport's valuation rose sharply from 1902 to 1906, and then declined to 1910, owing to the increase and decrease of the logging industry at that time, but has recovered steadily to the present.

Badoura and Crow Wing show similar trends in valuation. Both increased steadily until 1914, when they declined slightly to 1916, and then rose sharply to 1920, and have been declining since.

The townships in the middle of the county, representative of the rougher area, have experienced wide fluctuations in assessed value. That, no doubt, is due to the fact that the bulk of the virgin timber was found in this section. The data are not complete for the period up to 1910, and perhaps even up to 1916 are not entirely dependable. There are gaps of years where no property value is to be had, making it impossible to draw many general conclusions. All are relatively low in valuation.

Lake Emma and Mantrap show evidence of high values from 1896 to 1908, with a gradual increase to 1920, then holding their own to 1926, when Lake Emma showed a marked rise and Mantrap showed as marked a decline.

Clay, Clover, Lake George, and Schoolcraft townships show high valuations during 1902 to 1910. During the last decade, they have all maintained a rather steady value. In 1930 the range was from $90,710 in Schoolcraft to $110,091 in Clover.

Lake Hattie and Lake Alice show high valuations from 1904 to 1912, declining to low values in 1914, rising to 1920, and then declining.

Thorpe and Hendrickson had high values of $251,311 and $240,883, respectively, in 1906, due no doubt to timber values, with a decline to $67,814 and $80,341 in 1914, a rise to 1920, and a slight decline since. Thorpe has maintained its level of value somewhat more uniformly than Hendrickson during the last decade.

Steamboat River spurted to $315,008 from 1898 to 1900, likewise due to timber values, with no data before or after, until 1902 when the value of property was given as $76,860. Another higher level was reached in 1916 to 1918, then a decline through 1920 to $89,089 in 1930.

Arago had a high valuation of $58,596 in 1894, but declined to $4,038 in 1896. A high peak of $215,938 was reached in 1904 with a sharp decline to $60,990 in 1910. Then followed a gradual rise to 1918, a sharp rise to $206,865 in 1920, a sharp decline to 1922, and a little recovery in 1930, to $126,974.

In general, the townships that may lay valid claim to being agricultural show the most regular trend of assessed values. They likewise show the most definite upward trend during the entire period. The townships that had the merchantable timber show the most erratic values.

Akeley Township showed the highest value of property, $504,652, in 1910, owing to the inclusion of the village of Akeley with its then active sawmills. The next highest value, presumably due to lumber, is found for two years in Steamboat River, $315,088 and $318,429 in 1898 and 1900. The next highest value was in Thorpe, with $251,000 in 1906, due again to timber values. The high timber values in other townships about 1906 explain the rise in total values for the county at that time. It is of interest to compare the highest values in agricultural townships with these high values. Hubbard reached the high value of $348,229 in 1920 and had a value of $314,686 in 1930.

VALUE PER ACRE

The average assessed value per acre of rural land in 1928 ranged from $4.23 in Steamboat River District to $13.27 in Hubbard. Including the farm lands within the village limits, the top limit of the range was $15.70 for Park Rapids in Todd Township. The average assessed value for rural lands in the county was $6.72. In only four townships

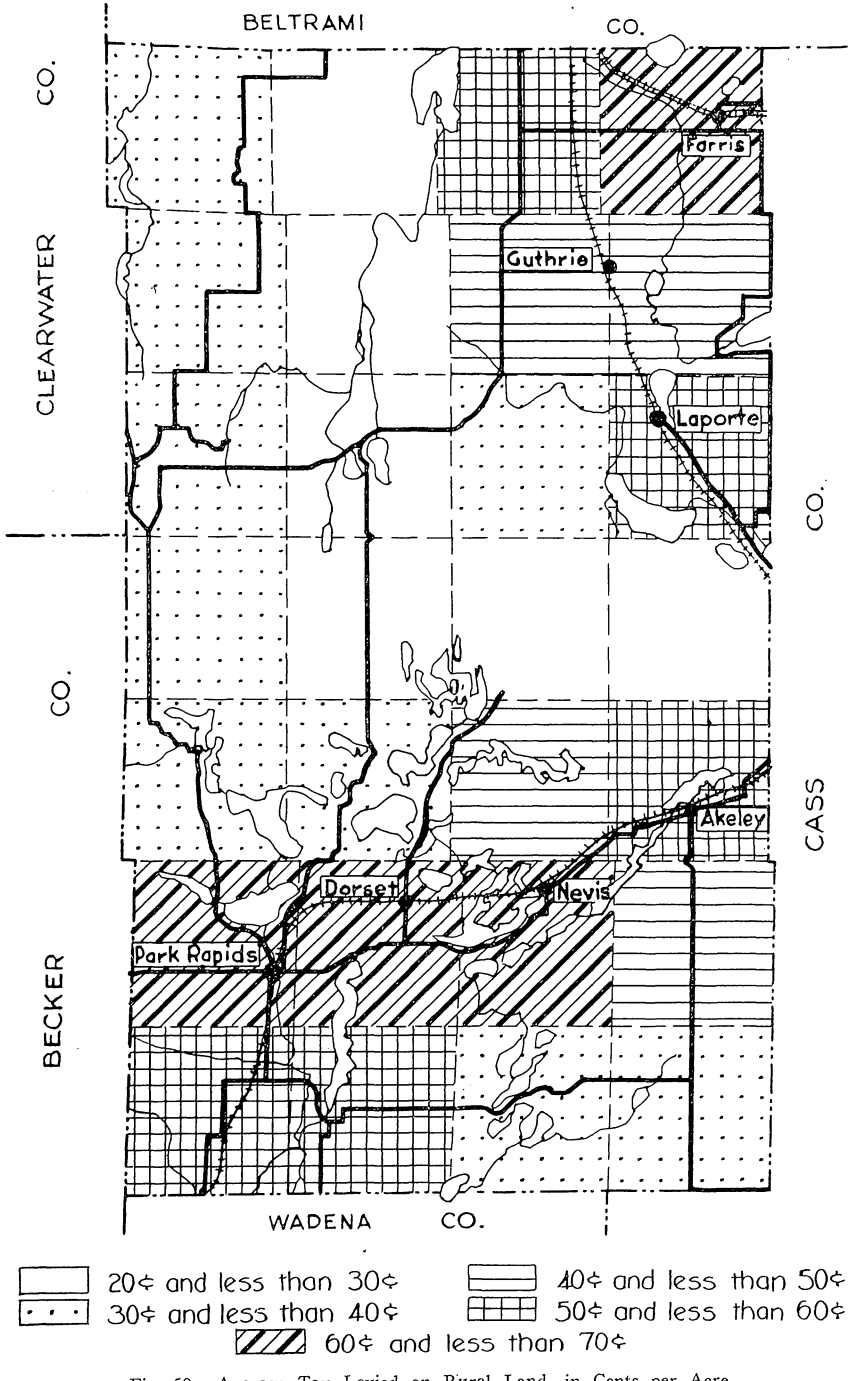

Fig. 59. Average Tax Levied on Rural Land, in Cents per Acre

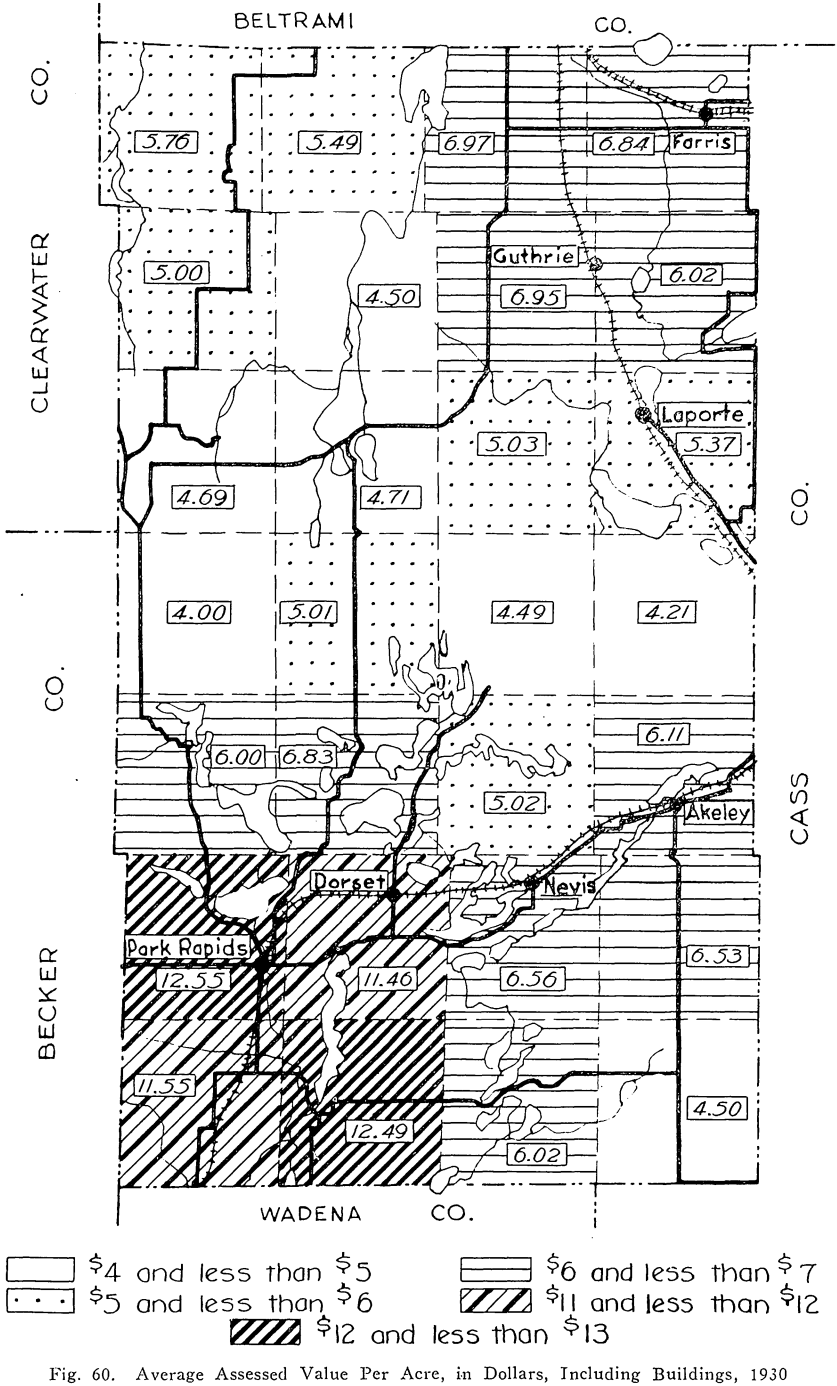

Fig. 60. Average Assessed Value Per Acre, in Dollars, Including Buildings, 1930

did the assessed value exceed $10, namely, Hubbard, Todd, Henrietta, and Straight River, with assessed values of $13.27, $13.21, $12.35, and $12.29, respectively. All four of these townships are located in the southwest corner of the county and have a relatively large part of their area in agricultural use. The assessed value then dropped to $7.13 per acre in Nevis Township. Eight townships had assessed values of six to seven dollars. They were Guthrie, Farden, Helga, White Oak, Akeley, Lake Emma, Fern, and Crow Wing Lake. Eleven townships had average assessed values of five to six dollars per acre, and four had assessed values from four to five dollars. These last four were Thorpe, Lake Alice, Schoolcraft, and Steamboat River, located in the central part of the county where more of the land is cut-over and very little of the area is in agricultural use. Figure 59 shows the average tax levied per acre by townships for 1928 and 1930. Figure 60 shows the land values based on average assessed value per acre including buildings and improvements.

TAX RATES

The average tax rates for townships and the county for the years from 1928 to 1930 were obtained from the tax abstract prepared by the county auditor. Similar rates were prepared by two-year periods as far back as the organization of the county. The average rates from the auditor's abstract were obtained by dividing the total taxes levied on real estate, excluding special assessments by the total valuation of real estate. These are not entirely accurate since the tax rates for school purposes vary within a township and county and presumably are not weighted. The average rates for years back are still less accurate since taxes levied include all taxes levied, and valuation does not include money and credits which are now taxed at a flat rate of three mills per dollar of true and full value. But they are believed to be sufficiently accurate for comparisons. Figure 61 shows average rate of taxes in mills for 1928.

The average tax rate for the whole county, including villages, for the year 1928 was 70.28 mills, and for 1930, 72.06 mills. The average tax rates for the villages were 107.02 mills for 1928 and 109.18 mills for 1930. The tax rate for the county exclusive of the villages was 62.90 mills for 1928 and 64.81 mills for 1930. The general trend was steadily upward until 1922 when the tax rate, exclusive of villages, was 71.06 mills and it has been declining slightly since that time. In 1920 the tax rate dropped to 43.55 mills from 63.46 mills in 1918. This may be explained by the fact that the valuation was raised in 1920, and the necessary taxes could be obtained with a lower rate.

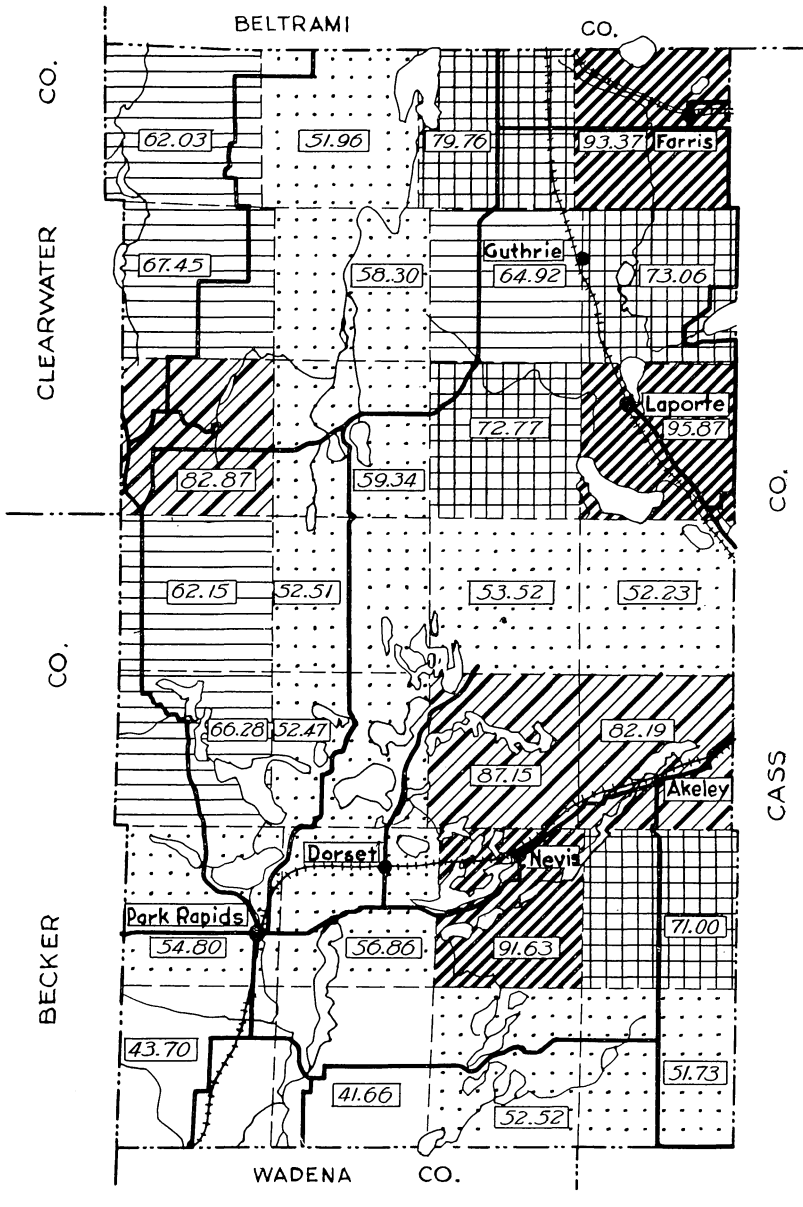

Fig. 61. Average Rate of Taxes, in Mills, for 1928
Average rate for the county, exclusive of villages, 62.9 mills.

The average tax rate for 1930 by townships, exclusive of villages, ranged from 40.02 mills for Hubbard Township to 102.35 mills for Lakeport. Mantrap, Farden, and Nevis rank next highest, with 93.99, 97.09, and 98.09 mills, respectively. These high rates may be attributed largely to high taxes for school purposs. Two townships had tax rates between 80 and 90 mills. They were Akeley and Helga with 87.72 and 84.55 mills, respectively. Six townships, Hendrickson, Hart Lake, Lake Alice, Guthrie, Clover, and Lake Hattie, had tax rates of 79.74, 79.37, 75.42, 73.67, 70.86, and 70.14 mills, respectively. Four townships had rates between 60 and 70 mills. They were White Oak, Lake George, Schoolcraft, and Arago, with 68.87, 65.90, 65.80, and 60.30 mills, respectively. Seven townships had tax rates between 50 and 60 mills. They were Fern, Lake Emma, Henrietta, Thorpe, Rockwood, Todd, and Steamboat River, with 59.41, 56.68, 56.35, 54.07, 53.91, 51.47, and 50.88, respectively. Five townships had tax rates of from 40 to 50 mills. These were Badoura, 48.15 mills; Crow Wing, 47.34 mills; Clay, 47.13 mills; Straight River, 45.24 mills, and Hubbard, 40.02 mills. In 17 townships the tax rate increased from 1928 to 1930, and in eleven it decreased. In 19 townships the valuation was lower in 1930 than in 1928, and in nine it was higher. In nine townships both valuation and tax rate were decreased. Seven townships raised both valuation and tax rate with a definite increase in taxes levied. Eleven townships either raised their valuation or decreased their tax rate, with no definite change in taxes levied probable. In fact, in just half of the county the tax levy increased and in half it decreased. In the county, as a whole, the valuation decreased slightly, but the tax rate was increased enough more to raise the total tax levied. Figure 62 shows the average total tax rate by townships for 1930.

TAXES LEVIED

The total taxes levied in the county, including villages, ranged from $5,854.56 in 1886 to $380,999.78 in 1922 and then declined to $352,-636.74 in 1930. The amount levied increased steadily until 1920, when there was a definite decline, with a sharp rise to the peak in 1922. For the county, excluding villages, the amount levied ranged from $5,393.43 in 1886 to $287,201.87 in 1924 and then declined to $262,694.24 in 1930. The amount of tax levied by townships in 1930 varied from $4,532.50 in Steamboat River to $15,184.42 in Henrietta.

In general, the eight townships in the south end of the county are similar in their tax levy. Hubbard Township may be considered typical in this respect. The tax levy increased steadily until 1922, when it declined to the present. The eight townships in the middle are similar,

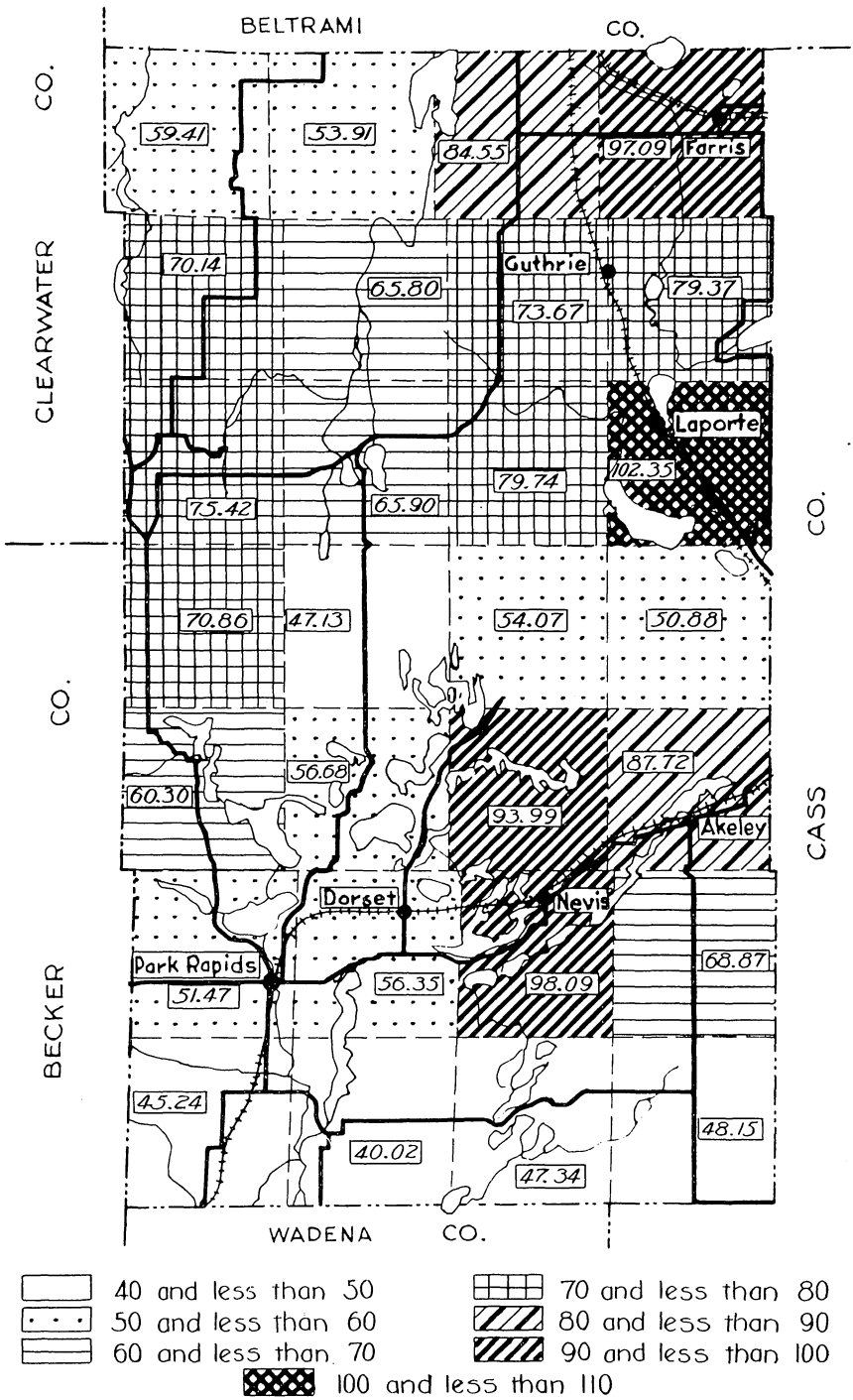

Fig. 62. Average Tax Rate, in Mills, Except Special Assessments (From auditor's Tax Abstract, 1930)

with Steamboat River and Thorpe representative. The taxes levied, as indicated by all data available, were high between 1900 and 1910, followed by a sharp decline and then a gradual rise to about 1920, and a decline since. Some of these townships have not levied as high a tax as they had in the decade 1900-1910, due, no doubt, to the value of timber logged at that time. Data on these townships are not complete as they were included in precincts or districts and were not designated as individual townships prior to that time. Hendrickson, Lake Alice, Lake Hattie, and Fern may be included in this group.

Lakeport, Hart Lake, Guthrie, Farden, and Helga are similar in that their tax levy rose rather rapidly from about 1900 to 1924 and then declined to the present. Lake George, Schoolcraft, and Rockwood showed no marked change in tax levy.

TAXES PAID

The taxes paid for the county as a whole ranged from $4,738.94 in 1886 to $294,926.00 in 1922, then declined to $247,759.72 in 1926, and rose slightly to $249,409.16 in 1928.

The taxes paid by the county, excluding the villages, showed a similar trend, ranging from $4,405.52 in 1886 to $214,652.56 in 1922 and declined to $172,081.18 in 1926 and to $168,375.18 in 1928. While the taxes levied have declined slightly since 1922, the decline in taxes paid has been more abrupt, indicating a decrease in ability to pay taxes. This is largely due to the post-war agricultural depression and the disparity between prices paid by farmers for goods bought and prices received for products sold. The fact that total taxes paid by the county as a whole did not continue to decline from 1926 to 1928, as did the taxes for the county exclusive of villages, suggests that the villages were relatively better able to pay their taxes than the rural part of the county. (See Fig. 63.)

The townships paying the largest amount of taxes and with the steadiest upward trend are the four oldest townships with the largest proportion of their area in agricultural use. They are Henrietta, Todd, Hubbard, and Straight River, in order. Nevis Township may be included in this group, but has a more irregular trend of tax payment.

The five northeastern townships, Helga, Guthrie, Farden, Hart Lake, and Lakeport, showed a rather rapid upward trend in tax payment in keeping with their development until 1922. Since that time they have declined. Akeley, White Oak, Crow Wing, and Badoura showed a somewhat slower and steadier upward trend, with relatively less decline in recent years, especially in the case of White Oak and Crow Wing. Lake Emma, Arago, and Mantrap rank next as a tax-paying group.

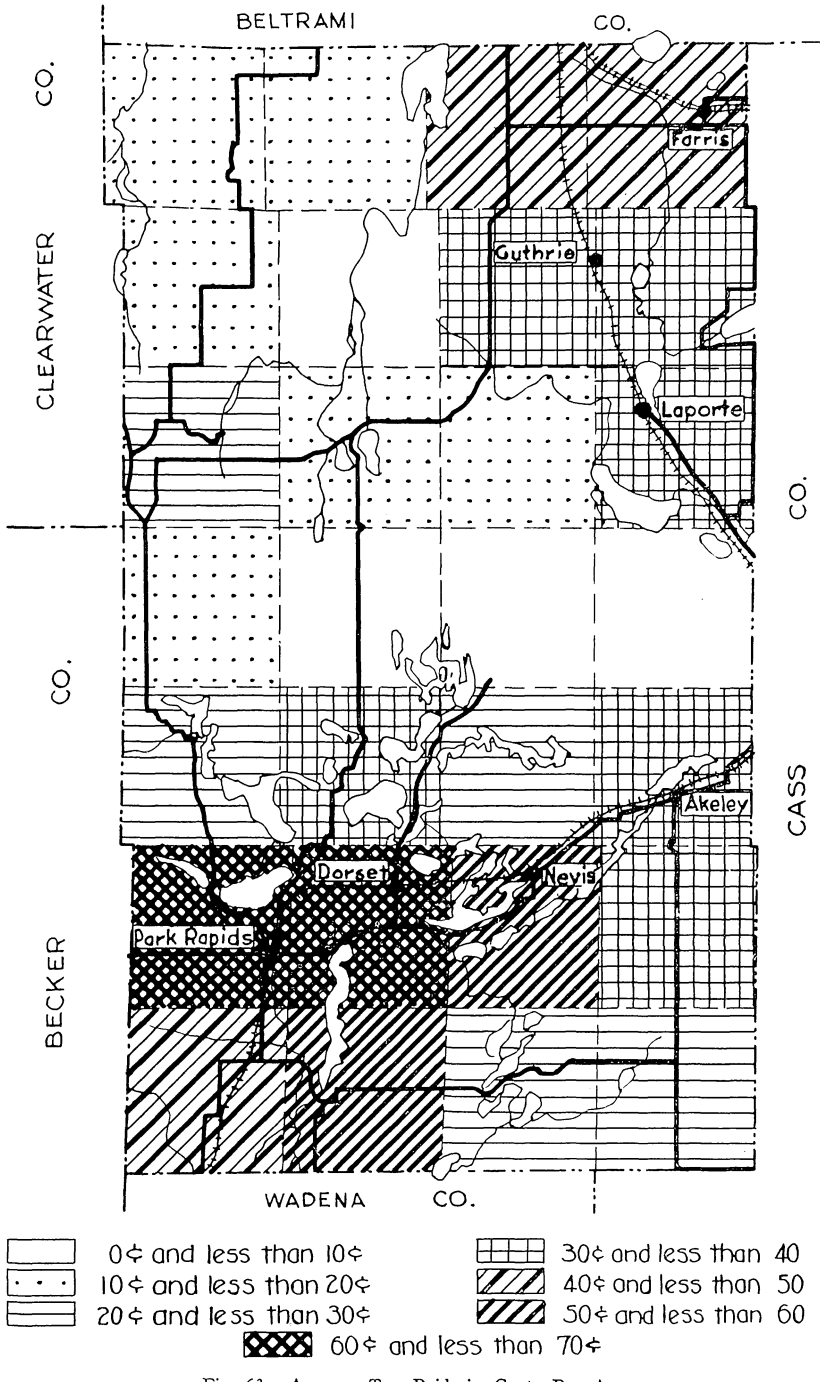

Fig. 63. Average Tax Paid, in Cents Per Acre

Table 72

Average Tax Paid per Acre in 1928

	Cents		Cents
Badoura	25.9	Clover	12.2
Crow Wing	28.8	Lakeport	35.0
Hubbard	56.24	Hendrickson	13.7
Straight River	43.0	Lake George	17.1
White Oak	34.1	Lake Alice	25.9
Nevis	52.0	Hart Lake	34.4
Henrietta	68.6	Guthrie	39.3
Todd	68.6	Schoolcraft	8.6
Akeley	39.2	Lake Hattie	17.4
Mantrap	24.0	Farden	48.4
Lake Emma	33.5	Helga	48.9
Arago	27.5	Rockwood	17.2
Steamboat River	4.33	Fern	18.2
Thorpe	6.5		
Clay	7.5	County average	29.74

They are similar in the fact that they show evidence of having had large tax levies between the years 1898 and 1908, presumably due to lumbering, and then going into a decline from which they have recovered somewhat, owing to the development of their resources in recreation and agriculture.

The eight townships in the northwestern part of the county are similar in that their tax payment showed no marked tendency to rise. Fern is the possible exception in that its tax payment was practically as high in 1928 as in any previous year. Lake Hattie made its largest tax payment in 1918 and 1922 when it paid $5,251.59 and $5,112.63, respectively, while Clay paid $5,231.06 in 1922.

Thorpe and Steamboat River made their highest tax payments, $8,268.88 and $6,838.27, in 1906 and 1900, respectively, presumably from timber.[2] Thorpe reached a high point again in 1922, with $5,193.51, and declined to $1,363.38 in 1928. Steamboat River reached another high point in 1918, with $5,361.74, and declined steadily to $916.09 in 1928.

Hendrickson has had varying tax payments, increasing from 1902 to 1908, with a decline for 1912-14, followed by a recovery to 1920 when it paid $7,922.99, and a sharp decline to $3,120.92 in 1926 and $3,085.96 in 1928.

Lake Alice reached a high point in tax payment in 1910, with $7,620.53, no doubt from timber, and declined to $2,595.04 in 1928.

Table 72 and Figure 63 show the average tax paid per acre in 1928.

The tax paid per acre for the county, exclusive of villages, in 1928 was 29.74 cents. The range in townships was from 4.33 cents in Steamboat River to 68.6 cents in Henrietta and Todd. The townships of Henrietta, Todd, Hubbard, Nevis, and Straight River were highest in

[2] These districts included more than a single township in the early years and hence comparisons are not so significant.

the south end of the county. The group of townships paying on an average less than 10 cents per acre tax were Schoolcraft, Clay, Thorpe, and Steamboat River.

DELINQUENT TAXES

Tax delinquency on real estate is very definitely a result of economic conditions affecting land use. It is an indication of how well land is being utilized from the standpoint of yielding income and how well the burden of supporting public institutions is adjusted to the varying abilities and opportunities land has of yielding such income. Tax delinquency must be ascertained over a period of time because the situation in any given year may be affected by conditions which may be purely temporary and therefore not representative of the long-time use of land.

Data on tax delinquency for the county were obtained from the tax records of the county back to 1884. The early records are not entirely dependable because the tax data could not always be separated for individual townships prior to their organization. The total amounts of all taxes levied on real and personal property, the total taxes paid, and the total taxes uncollected or delinquent were taken for each year and the per cent of delinquent or uncollected taxes of the total taxes levied was calculated. (See Fig. 64.)

Only about one-half of one per cent of the taxes levied were uncollected in 1890, while the figure for 1929 was 35.28 per cent. The increase has been gradual and steady for the greater part of this period. During the period from 1902 to 1912 the percentage of delinquency rose to 17.76 per cent in 1908 and dropped back to 8.47 per cent in 1912. The amount of annual delinquent taxes grew with a marked increase in 1908, followed by a decline, resulting in a total of $128,019 of uncollected taxes for 1929. The total amount[3] of uncollected taxes on the first Monday of January, 1929, was $284,575; 1930, $351,623; 1931, $452,412; and 1932, $543,477 or nearly a doubling in four years.

When villages are excluded the trend of tax delinquency for the remainder of the county is very similar to the above except that it is somewhat higher than that for the complete county. The range is from 0.59 per cent in 1890 to 35.88 per cent in 1928. This would indicate that delinquency in general is higher on strictly rural property and that rural property evidently bears a relatively heavier burden of taxes in proportion to its ability to pay.

There is evident a marked difference in trend of tax delinquency among the townships. They may be grouped as to similarity of trend and represented by the trend of a typical township. The first group

[3] Report on Uncollected Taxes, Minnesota Tax Commission.

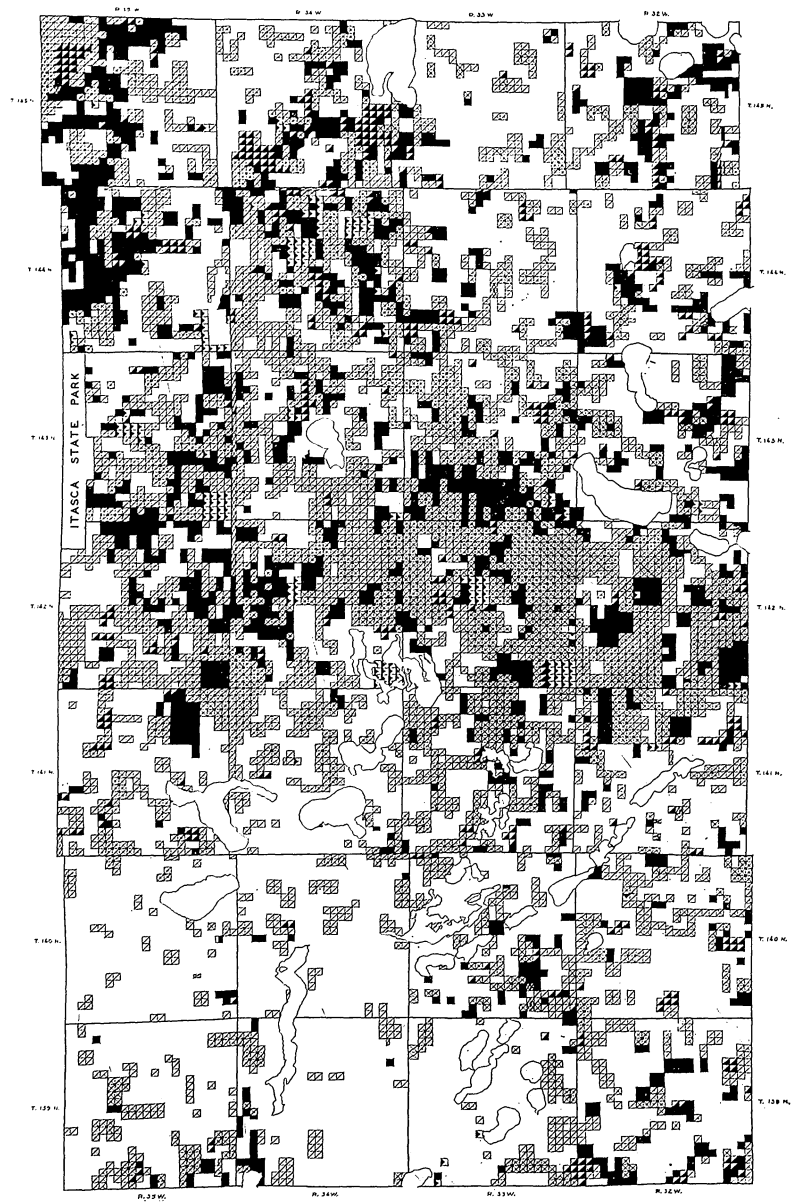

Fig. 64. Various Stages of Tax Delinquency in Hubbard County, January 1930

to be considered is composed of Todd, Henrietta, Straight River, Hubbard, and Crow Wing Lake. The trend is typified by Todd Township which showed a rise from 0.19 per cent delinquency in 1890 to 15.76 per cent in 1928. The highest percentage of these townships is 24.05 per cent for Straight River in 1928. The lowest for 1928 is Crow Wing Lake, with 12.28 per cent delinquency. This may be due to the fact that water-power companies owned 31 per cent of the area of the township, none of which was delinquent.

Another group similar in trend includes Helga, Guthrie, Hart Lake, and Lakport. They show a somewhat higher delinquency in preceding years, but all decline in delinquency from 1926 to 1928. The lowest delinquency for 1928 was shown by Helga, with 19.88 per cent, and the highest by Guthrie, with 25.09 per cent. Up to 1926 this group showed a slightly greater tendency to rise in delinquency than the preceding group. Lake Emma might have been included in this group as it had a similar delinquency trend, but it was not otherwise typical of this group. Its delinquency declined from 1926 to 1928, when 26.96 per cent was delinquent. This is, no doubt, due to development of recreation property which as a rule is not delinquent.

A third group is composed of Akeley, Farden, Arago, White Oak, Nevis, and Badoura. Their trends of delinquency rise more rapidly than those of the preceding group. The highest percentage is 34.53 per cent for Akeley and the lowest is 30.80 for Badoura for 1928. Delinquency in all except Akeley increased from 1926 to 1928.

In the last group delinquency showed a marked tendency to increase, especially from 1918 to 1928. Up to that time percentage delinquency was relatively low, with occasional exceptions. This group is made up of Steamboat River, with 80.38 per cent delinquent for 1928; Thorpe, 75.43; Clay, 71.88; Schoolcraft, 69.25; Hendrickson, 63.95; Lake Alice, 63.46; Clover, 62.00; Lake George, 55.26; Fern, 53.79; Lake Hattie, 49.59; Mantrap, 48.53, and Rockwood, 43.75. These townships show proportionately less agricultural use than the other townships of the county and a larger per cent of residual or cut-over and generally idle land than the other townships. The income derived from within each township is relatively small and explains the relatively high tax delinquency. Figure 65 shows the average tax delinquency of each township as to taxes of 1928 payable in 1929.

According to data taken from the delinquency tax record at the county auditor's office up to January, 1930, there were 261,160.63 acres delinquent in January, 1930, or 44 per cent of the total land area of the county. On this acreage a total of $360,154.24 was uncollected at that time, or $1.38 per acre. Distributed over the entire area of the county,

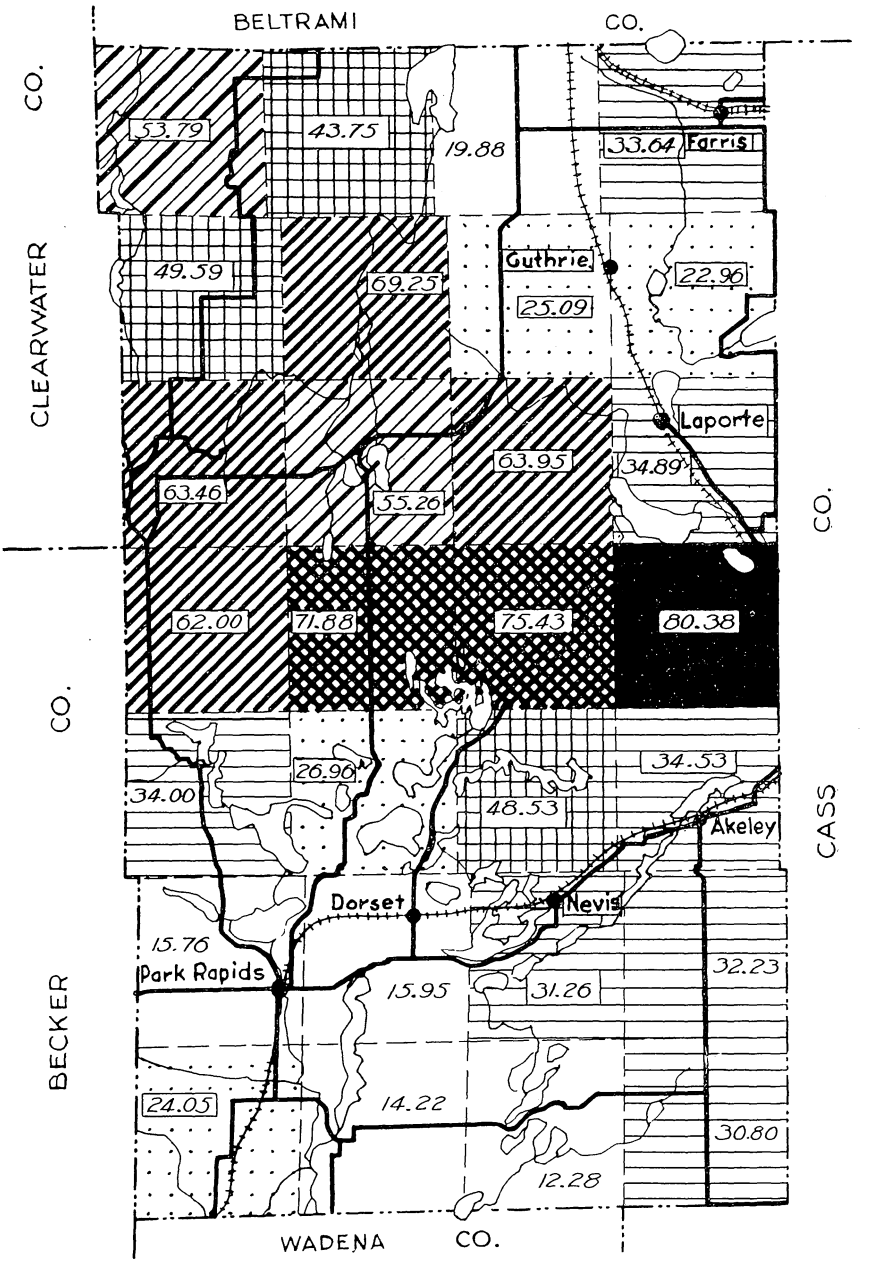

Fig. 65. Tax Delinquency by Townships in Percentage of Taxes Levied, 1928

the uncollected taxes at that time amounted to 60 cents per acre. According to the report on uncollected taxes in the state, from the office of the tax commission, $543,477 were uncollected in January, 1932, or 91 cents for each acre in the county. The same source reports $284,575 uncollected in January, 1927, or 50 cents for each acre in the county. The increase in recent years is due mainly to the period of depression, but the increase in 1929 and 1930 was caused in part, at least in some townships, by the unusual drouth conditions in the county, with a marked decrease in crop production during these years. Table 73 gives the detailed summary of tax delinquency in the county in acres and dollars, and Table 74 gives the same data in percentages.

The area delinquent by townships ranged from 17,807.56 acres in Thorpe to 2,201.71 acres in Todd, or 80.13 per cent of the total area of Thorpe and 11 per cent of Todd. Eleven townships had over one-half of their area delinquent. They were Thorpe, Steamboat River, Clay, Hendrickson, Clover, Schoolcraft, Fern, Lake George, Mantrap, Lake Hattie, and Lake Alice. These townships are largely cut-over or border on strictly cut-over townships with adjacent fringes cut-over and idle. Five townships had 40 to 50 per cent of their area delinquent. They were Rockwood, Lakeport, Akeley, Farden, and Arago. These townships have more agricultural development and represent areas that are on the borderline between agriculture and forstery. Townships with thirty to forty per cent of their area delinquent were Lake Emma, Nevis, Guthrie, White Oak, and Hart Lake. These townships have more agricultural development or recreational value. There were three townships with twenty to thirty per cent of their area delinquent. They were Badoura, Helga, and Straight River. This group has distinctly more agricultural development. Townships with delinquent area of from 10 to 20 per cent were Crow Wing, Henrietta, Hubbard, and Todd. These townships are largely agricultural, with the exception of Crow Wing which has large water-power holdings.

The amount delinquent per acre for the county was $1.38. For the various townships this ranged from $2.75 in Farden to $0.59 in Crow Wing. Lakeport had $2.28 average delinquency per acre. The high delinquency in these townships may be due to high tax for school purposes. Twenty-four townships had an average delinquency from $1 to $2 per acre. Only two had an average delinquency of less than $1. They were Lake Emma with $0.85 and Crow Wing with $0.59.

The total acreage in the county that has been delinquent at some time, including that which had been delinquent and redeemed or cancelled and the area that was still delinquent in January, 1930, was 430,061 acres or 72 per cent of the total area of the county. By townships, it ranged from

Table 73

Tax Delinquency in Hubbard County, January 1, 1930

Township	Now delinquent			Acres paid since 1928, with some tax now delinquent	Paid Nov. 1, 1929 to May 1, 1930			Acres delinquent paid before Nov. 1, 1929	Acres delinquent and cancelled	Total acres ever delinquent
	Acres	Amount	Average per acre		Acres	Amount	Average per acre			
Akeley	9,146.72	15,260.82	1.67	160.00	555.54	1,305.39	2.35	7,809.56	520.00	18,031.82
Arago	8,585.89	10,267.81	1.20	.....	904.20	708.67	0.78	4,052.15	.....	13,542.24
Badoura	6,634.68	8,727.69	1.32	.....	519.00	276.04	0.53	5,162.63	880.00	13,196.31
Clay	15,912.96	16,260.03	1.02	.....	134.25	40.72	0.30	1,611.80	.....	17,659.01
Clover	14,099.32	16,385.55	1.16	160.00	680.00	418.69	0.50	1,974.87	.....	16,754.19
Crow Wing Lake	3,446.59	2,020.52	0.59	.....	312.38	264.58	0.85	5,849.74	667.80	10,276.51
Farden	8,642.99	23,768.73	2.75	61.10	759.25	910.34	1.10	6,602.63	361.31	16,366.18
Fern	12,957.25	18,975.47	1.46	.....	882.50	692.81	0.79	4,434.47	480.00	18,754.22
Guthrie	7,388.42	9,525.79	1.29	259.23	280.00	349.87	0.65	7,301.11	635.28	15,604.81
Hart Lake	6,520.83	11,322.73	1.74	.....	802.30	1,105.53	1.38	6,842.30	193.65	14,359.08
Helga	5,242.13	7,403.02	1.41	240.00	551.14	709.62	0.90	8,406.38	840.00	15,039.05
Hendrickson	16,052.41	28,412.99	1.77	229.96	356.42	577.04	0.98	3,993.51	268.12	20,670.46
Henrietta	3,535.15	4,709.71	1.33	.....	.....	.....	...	5,391.92	75.00	9,002.07
Hubbard	3,240.71	5,285.51	1.63	80.00	1,119.61	1,071.78	0.89	4,518.64	.....	8,878.96
Lake Alice	11,382.46	15,763.09	1.38	80.00	748.25	753.69	0.91	2,951.20	4,012.69	19,094.60
Lake Emma	6,647.42	5,652.46	0.85	.....	335.77	792.94	2.36	4,131.76	.....	11,114.95
Lake George	12,123.45	12,223.62	1.01	.....	839.05	440.11	0.52	2,189.57	640.00	15,792.07
Lake Hattie	11,262.62	17,924.25	1.59	410.42	649.50	1,019.42	0.96	5,977.40	808.98	18,698.50
Lakeport	8,346.04	19,011.40	2.28	80.00	577.70	855.19	1.30	6,023.65	213.80	15,161.19
Mantrap	10,780.36	16,110.34	1.49	120.00	1,296.89	1,203.41	0.85	4,120.06	.....	16,197.31
Nevis	6,668.52	13,583.73	1.04	.....	1,001.84	1,553.70	1.55	6,118.93	160.00	13,949.29
Rockwood	9,946.65	11,454.20	1.15	120.00	604.36	446.26	0.62	5,812.31	320.00	16,683.32
Schoolcraft	13,871.23	15,806.10	1.14	80.00	400.00	732.09	1.53	2,462.20	360.00	17,093.43
Steamboat River District	16,452.65	17,528.92	1.07	236.75	740.00	672.48	0.69	2,292.37	1,080.09	20,565.11
Straight River	5,194.04	6,530.85	1.26	.....	1,588.78	1,504.59	0.95	7,132.72	.....	13,915.54
Thorpe	17,807.56	18,311.90	1.03	.....	40.00	9.33	0.23	1,839.50	120.00	19,807.06
Todd	2,201.71	3,992.12	1.81	.....	1,194.29	1,059.24	0.89	4.593.61	.....	7,989.61
White Oak	7,069.87	7,934.89	1.12	.....	1,652.10	1,083.57	0.66	6,675.54	470.63	15,868.14
Total, county	261,160.63	360,154.24	1.38	2,317.46	19,525.12	20,557.10	0.94	136,272.53	13,107.35	430,065.63

Table 73—Continued

Tax Delinquency in Hubbard County, January 1, 1930

	Acreage for number of times delinquent						Acreage for number of years delinquent			
	1	2	3	4	5	6	1928 alone	1 to 5	6 to 10	11 to 15
Akeley	6,669.70	4,896.84	3,295.94	2,472.36	496.98	200.00	115.10	9,244.41	6,872.10	1,800.21
Arago	6,022.38	3,555.56	2,937.47	1,026.83	.....	.....	595.50	8,389.91	4,272.58	284.25
Badoura	6,196.53	4,438.14	2,041.64	360.00	.....	160.00	361.00	8,111.63	4,323.68	400.00
Clay	13,370.00	2,196.80	1,448.46	363.75	280.00	.....	1,365.35	10,615.25	5,518.41	160.00
Clover	12,149.22	2,541.58	1,741.14	282.25	40.00	.....	1,330.90	9,913.13	5,350.16	160.00
Crow Wing Lake	5,291.59	2,839.41	1,506.51	248.50	390.50	.....	.....	8,145.00	2,131.51	.....
Farden	5,791.43	4,444.56	3,128.78	1,828.24	878.00	295.17	487.45	9,617.97	4,403.16	1,857.60
Fern	6,891.40	6,672.10	3,389.38	1,201.34	400.00	200.00	.....	8,388.64	7,649.87	2,715.71
Guthrie	6,277.94	5,153.77	2,628.42	1,144.68	240.00	160.00	240.00	10,550.30	3,873.17	941.34
Hart Lake	6,366.40	3,294.79	2,456.89	1,158.30	420.00	662.70	158.00	8,986.29	3,969.29	1,245.50
Helga	6,247.14	4,579.13	2,299.13	1,476.37	358.30	79.58	236.82	10,369.18	3,621.85	811.80
Hendrickson	12,728.81	3,208.38	2,700.64	1,153.22	439.12	440.29	360.27	10,736.44	7,620.62	1,953.13
Henrietta	3,961.73	3,405.52	1,122.66	379.59	132.57	.....	603.36	7,655.95	742.26	0.50
Hubbard	4,963.58	2,179.85	1,180.81	434.72	120.00	.....	984.04	5,518.85	2,102.06	274.01
Lake Alice	12,604.55	3,377.01	2,433.04	520.00	160.00	.....	1,699.20	7,125.79	9,325.28	944.33
Lake Emma	5,912.62	2,817.35	1,840.18	388.55	94.00	62.25	264.11	8,725.84	2,083.50	41.50
Lake George	8,005.39	4,279.01	2,159.42	1,228.25	120.00	.....	1,293.00	8,164.70	5,664.87	669.50
Lake Hattie	9,518.16	5,023.68	2,527.78	1,442.81	146.05	40.00	235.55	7,885.43	5,919.82	657.70
Lakeport	5,535.72	4,439.48	2,910.44	1,461.46	520.34	293.75	577.80	7,311.45	5,624.31	1,647.63
Mantrap	6,458.41	4,162.15	3,628.13	1,691.10	257.52	.....	310.35	9,631.64	5,695.32	560.00
Nevis	5,304.82	4,558.04	2,656.10	1,302.20	113.13	15.00	895.30	7,697.93	4,654.81	701.25
Rockwood	6,841.75	5,088.05	2,343.13	1,716.14	519.00	175.25	480.11	10,438.71	4,497.51	1,267.10
Schoolcraft	7,956.13	4,936.30	1,392.15	1,815.85	713.00	280.00	920.45	9,534.37	4,892.61	1,746.00
Steamboat River District	12,322.10	5,309.90	2,125.64	517.95	117.40	172.12	120.00	13,146.92	5,595.67	1,702.52
Straight River	7,792.79	3,812.05	917.07	1,273.63	120.00	.....	1,000.00	10,387.59	2,449.95	80.00
Thorpe	15,781.06	2,066.00	1,400.00	560.00	.....	.....	162.00	15,371.79	3,713.27	560.00
Todd	4,177.60	2,172.10	653.04	362.75	624.12	.....	516.03	6,113.24	1,193.54	166.80
White Oak	5,342.38	4,154.03	3,652.14	2,559.59	160.00	.....	246.15	9,595.85	5,465.41	560.73
Total, county	216,481.35	109,601.58	62,516.13	30,370.43	7,860.03	3,236.11	15,557.73	257,372.20	133,226.59	23,909.11

Average amount per acre delinquent over entire county: January 1, 1929, .4975; January 1, 1930, .5893; January 1, 1931, .7580.

Table 74

Percentages of the Acreage of the County in the Various Stages of Delinquency, as of January 1, 1930

Township	Now delinquent	Paid in full Nov. 1, 1929 to May 1, 1930	Paid in full Delinquent and cancelled	Delinquent, paid before Nov. 1, 1929	Percentage ever delinquent	Acreage for number of times delinquent 1	2	3	4	5	6	Acreage for number of years delinquent 1928 alone	1-5	6-10	11-15	Total acreage
Akeley	41.88	2.54	2.38	35.76	82.56	30.54	22.42	15.09	11.32	2.28	0.91	0.53	42.33	31.46	8.24	21,841.74
Arago	42.64	4.49	....	20.12	67.25	29.90	17.66	14.59	5.10	....	....	2.96	41.66	21.22	1.41	20,137.03
Badoura	29.08	2.27	3.86	22.62	57.83	27.15	19.45	8.95	1.58	....	0.70	1.58	35.55	18.95	1.75	22,818.80
Clay	72.57	0.61	....	7.35	80.53	60.97	10.02	6.60	1.66	1.28	....	6.23	48.40	25.17	0.73	21,927.69
Clover	64.46	3.10	....	9.03	76.59	55.54	11.62	7.96	1.29	0.18	....	6.08	45.32	24.46	0.73	21,874.31
Crow Wing Lake	17.71	1.60	3.43	30.06	52.80	27.19	14.59	7.74	1.28	2.00	....	....	41.85	10.95	....	19,462.38
Farden	40.01	3.51	1.67	30.56	75.75	26.81	20.57	14.48	8.46	4.06	1.37	2.26	44.51	20.38	8.60	21,605.13
Fern	57.99	3.95	2.15	19.85	83.94	30.85	29.86	15.17	5.38	1.79	0.90	....	37.54	34.24	12.16	22,342.03
Guthrie	32.71	1.24	2.81	32.32	69.08	27.79	22.81	11.64	5.07	1.06	0.71	1.06	46.70	17.15	4.17	22,589.63
Hart Lake	30.16	3.71	0.90	31.64	66.41	29.44	15.24	11.36	5.36	1.94	3.07	0.73	41.56	18.36	5.76	21,635.33
Helga	24.35	2.56	3.90	39.04	69.85	29.01	21.27	10.68	6.86	1.66	0.37	1.10	48.16	16.82	3.77	21,532.70
Hendrickson	70.08	1.56	1.17	17.43	90.24	55.57	14.01	11.79	5.03	1.92	1.92	1.57	46.87	33.27	8.53	22,904.97
Henrietta	16.86	....	0.36	25.72	42.94	18.90	16.25	5.35	1.81	0.63	....	2.88	36.52	3.54	....	21,008.31
Hubbard	15.04	5.20	....	20.99	41.23	23.05	10.12	5.48	2.02	0.56	....	4.57	25.63	9.76	1.27	21,580.68
Lake Alice	51.81	3.41	18.26	13.43	86.91	57.37	15.37	11.07	2.37	0.73	....	7.73	32.44	42.44	4.30	21,971.10
Lake Emma	37.61	1.90	....	23.38	62.89	33.46	15.94	10.41	2.20	0.53	0.35	1.49	49.38	11.79	0.23	17,672.63
Lake George	55.98	3.88	2.96	10.11	72.93	36.97	19.76	9.97	5.67	0.56	....	5.97	37.71	26.16	3.09	21,652.68
Lake Hattie	53.02	3.06	3.81	28.14	88.03	44.81	23.65	11.90	6.79	0.69	0.19	1.10	37.12	46.71	3.10	21,241.29
Lakeport	42.86	2.97	1.10	30.93	77.86	28.43	22.80	14.95	7.50	2.67	1.51	2.97	37.55	28.88	8.46	19,472.60
Mantrap	53.82	6.48	....	20.57	80.87	32.25	20.78	18.11	8.44	1.29	....	1.55	48.08	28.44	2.80	20,028.66
Nevis	35.91	5.40	0.86	32.95	75.12	28.57	24.55	14.30	7.01	0.61	0.08	4.82	41.45	25.07	3.78	18,569.92
Rockwood	46.79	2.84	1.51	27.34	78.48	32.19	23.94	11.02	8.07	2.44	0.82	2.26	49.10	21.16	5.96	21,257.06
Schoolcraft	63.38	1.83	1.64	11.25	78.10	36.35	22.55	6.36	8.30	3.26	1.28	4.21	43.56	22.35	7.98	21,887.05
Steamboat River District	73.47	3.31	4.82	10.24	91.84	55.03	23.72	9.49	2.31	0.52	0.77	0.54	58.71	24.99	7.60	22,392.72
Straight River	23.18	7.09	....	31.84	62.11	34.78	17.02	4.09	5.68	0.54	....	4.46	46.35	10.94	0.36	22,495.40
Thorpe	80.13	0.18	0.54	8.28	89.13	71.01	9.30	6.30	2.52	....	....	0.73	69.17	16.71	2.52	22,224.35
Todd	10.63	5.76	....	22.17	38.56	20.16	10.49	3.15	1.75	3.01	....	2.49	29.50	5.76	0.81	20,720.69
White Oak	32.12	7.50	2.14	30.33	72.09	24.27	18.87	16.59	11.63	0.73	....	1.12	43.59	24.83	2.55	22,011.36
Total, county	43.77	3.27	2.20	22.84	72.08	36.28	18.37	10.48	5.09	1.32	0.54	2.61	43.14	22.33	4.00	596,858.24

20,565 acres in Steamboat River, or 92 per cent of its area, to 7,990 acres in Todd, or 39 per cent of its area. Nine townships had 80 per cent or more of their area delinquent. These townships were Steamboat River, Hendrickson, Thorpe, Lake Hattie, Lake Alice, Fern, Akeley, Mantrap, and Clay. Eight townships had 70 to 80 per cent of their area delinquent. They were Rockwood, Schoolcraft, Lakeport, Clover, Farden, Nevis, Lake George, and White Oak. Six townships had 60 to 70 per cent of their area delinquent. They were Helga, Guthrie, Arago, Hart Lake, Lake Emma, and Straight River. Two townships, Badoura and Crow Wing, had from 50 to 60 per cent of their area delinquent. Two townships, Henrietta and Hubbard, had from 40 to 50 per cent of their area delinquent. Todd had the lowest percentage, 39. It is evident that the percentage of land area which has been delinquent at some time is high, not only for the county as a whole, but that a large proportion of the townships had high percentages delinquent and that even the lowest township had a distinctly high delinquency percentage. While the delinquency in 1930 was materially lower, 44 per cent of the area, and the range from 11 to 80 per cent, the greatest change has been at the lower limit. Whereas only one township had less than 40 per cent of land in delinquency at one time, there were 12 townships below that limit in delinquency in January 1930 and all of these were located in the south end and northeast corner of the county. All of these will be found in relatively high income producing groups, in agriculture, recreation, or potential water-power.

Delinquencies were examined from the viewpoint of the number of different times a given description of land had been delinquent. It was found that some land had been delinquent as many as six different times. The number of acres of each class were found to be as follows:

Number of times delinquent	Number of acres	Per cent of county area
1	216,481	36
2	109,602	18
3	62,516	10
4	30,370	5
5	7,860	1.3
6	3,236	0.5

The delinquency on income-producing land generally tends to be temporary, if the usual income is able to bear the tax. Such delinquency is the result of temporary or transient conditions, whereas idle land when once delinquent tends to remain so. Hence, in a county where delinquency is extensive, occasional or frequent delinquency probably tends to be associated with land producing steady and continuous income, while single or few delinquencies of long standing tend to be associated with idle land producing little or no income or having uncertain prospective

income. Detailed analysis into the association of frequency of delinquency with land use, type of ownership, climatic and economic conditions would be necessary to verify or disprove this assumption.

Thorpe Township had the highest percentage of its area delinquent once, dropping to 9.3 per cent twice, 6 per cent three times, 3 per cent four times, and no delinquencies five or six times. Clay had the next highest delinquency in the one-time class, with 61 per cent, dropping to 10 per cent in the two-times class, 6.60 in the three-times class, 2 in the four-times class, 1 in the five-times class, and none in the six-times class. Lake Alice had 57 per cent of the total delinquency in its one-time class, 15 in the second, 11 in the third, 2 in the fourth, 1 in the fifth, and none in the sixth. Other townships similar in this respect were Hendrickson and Clover with 56 per cent and Steamboat River with 55 per cent in the one-time class. All of these townships are largely cut-over. This suggests that taxes were paid until the timber was removed, and perhaps for a short time thereafter, with the intention of selling the land for other uses, but where this hope did not materialize, the payment of taxes was discontinued.

Henrietta had the lowest percentage in the one-time class, 19 per cent, 16 in the second, 5 in the third, 2 in the fourth, 1 in the fifth, and none in the sixth. Todd had 20 per cent in the one-time class, 10 in the second, 3 in the third, 2 in the fourth, and 3 in the fifth. Other townships similar in this respect were Hubbard, White Oak, Helga, Hart Lake, Crow Wing, Guthrie, Farden, Nevis, and Straight River. The townships with the highest percentage in the six-times class were Hart Lake, Farden, Hendrickson, Lakeport, and Schoolcraft.

Land that was delinquent in January, 1930, or which had been delinquent at some previous time, also was classified as to the length of time it was delinquent. The first class includes land that was delinquent for 1928 alone. In this class were 15,558 acres or 3 per cent of the total acreage ever delinquent. This is new delinquency. In view of the severe drouth conditions during 1929, and the resulting low crop production, a large amount of new delinquency would be expected in the agricultural townships that suffered most from the drouth, but the figures do not support this assumption. Lake Alice had the largest area in this new delinquency of any township, 1,699 acres. Clay Township was next with 1,365 acres, Clover next with 1,331 acres, then Lake George with 1,293 acres. All of these townships are largely cut-over and hence not directly affected by the drouth. Delinquency may have resulted because individual owners decided to stop tax payment because of no income from the land. Straight River had the next largest area of new delinquency, 1,000 acres. This may be traceable to the effect

of drouth on agriculture. Steamboat River had the smallest area of new delinquency, with 120 acres, and Thorpe was next, with 162 acres. This small increase in these two townships may be due to the fact that they already had the highest percentage of delinquency. Crow Wing Lake and Fern had no additional delinquency for 1928. In Crow Wing this may be due to the fact that it may be approaching a saturation point and that the water-power companies are holding land that would be submarginal for any other purpose. Fern had a very high percentage (58) of its area already delinquent.

Land which had been delinquent from one to five years, totaled 257,372 acres, or 43 per cent of the county. Thorpe, with 69 per cent of its area, had the largest percentage and Steamboat River was next, with 59 per cent. Seventeen townships had from 40 to 50 per cent of their area in this class; seven from 30 to 40 per cent, and two (Todd and Hubbard) from 20 to 30 per cent.

Delinquencies of from six to ten years included 22.33 per cent of the county area. Lake George and Lake Alice had the highest amounts in this class, both having more in this class than in that of one to five years delinquency, indicating a greater amount of long-time or permanent delinquency.

Four per cent of the area of the county had been delinquent 11 to 15 years. Fern (12 per cent), Farden (9 per cent), Hendrickson (9 per cent), Lakeport (8 per cent), and Akeley (8 per cent) had the largest amounts. Henrietta and Crow Wing Lake had no land in this group. Other townships with less than one per cent included Lake Emma, Straight River, Clay, Clover, and Todd.

A comparison of the percentage of total land that had been delinquent and that was delinquent in January, 1930, may give some indication as to the extent to which each township had reduced its delinquency. If the percentage of land area that was delinquent at the time of the survey is subtracted from the percentage of land area that had ever been delinquent, the difference will be the percentage of township area that had been redeemed. Dividing this difference by the percentage of total area delinquent gives the ratio of delinquent area that had been redeemed to total area delinquent. If a large percentage of the delinquent area in a township has been redeemed, it suggests that its land is relatively desirable or valuable.

Table 75 shows the percentage of township area that has ever been delinquent, the percentage delinquent in January, 1930, the percentage of area paid, and the ratio between the percentage paid and the percentage ever delinquent.

For the county as a whole 40.11 per cent of the delinquent area had been redeemed. This may be taken as a measure from which variation can be considered. The per cent redeemed by townships ranged from Todd with 72 per cent down to Clay with 10 per cent. In five townships, Crow Wing, Helga, Hubbard, Straight River, and Henrietta, 60 to 70 per cent of the delinquent land had been redeemed. Four townships, White Oak, Hart Lake, Guthrie, and Nevis have had 50 to

Table 75

Percentage of Delinquent Area Redeemed January, 1930

	Ever delinquent	Now delinquent	Redeemed	Per cent redeemed
Akeley	82.56	41.88	40.68	49.27
Arago	67.25	42.64	24.61	36.59
Badoura	57.83	29.08	28.75	49.71
Clay	80.53	72.57	7.96	9.88
Clover	76.59	64.46	12.13	15.84
Crow Wing	52.80	17.71	35.09	66.65
Farden	75.75	40.01	35.74	47.18
Fern	83.94	57.99	25.95	30.91
Guthrie	69.08	32.71	36.37	52.65
Hart Lake	66.41	30.16	36.25	54.59
Helga	69.85	24.35	45.50	65.14
Hendrickson	90.24	70.08	20.16	22.34
Henrietta	42.94	16.86	26.08	60.73
Hubbard	41.23	15.04	26.19	63.52
Lake Alice	86.91	51.81	35.10	40.39
Lake Emma	62.89	37.61	25.28	40.20
Lake George	72.93	55.98	16.95	23.24
Lake Hattie	88.03	53.02	35.01	39.77
Lakeport	77.86	42.86	35.00	44.95
Mantrap	80.87	53.82	27.05	33.45
Nevis	75.72	35.91	39.81	52.57
Rockwood	78.48	46.79	31.69	40.38
Schoolcraft	78.10	63.38	14.72	18.85
Steamboat	91.84	73.47	18.37	20.00
Straight River	62.11	23.18	38.93	62.68
Thorpe	89.13	80.13	9.00	10.10
Todd	38.56	10.63	27.93	72.43
White Oak	72.09	32.12	39.97	55.44
County	72.08	43.17	28.91	40.11

60 per cent redeemed. Seven townships have had 40 to 50 per cent redeemed. They are Badoura, Akeley, Farden, Lakeport, Lake Alice, Rockwood, and Lake Emma. Four, Lake Hattie, Arago, Mantrap, and Fern, have had 30 to 40 per cent redeemed. Two have had 20 to 30 per cent redeemed. They are Lake George and Hendrickson. Four townships, Schoolcraft, Clover, Thorpe, and Steamboat River, have had 10 to 20 per cent of their delinquency redeemed. Clay Township had less than 10 per cent redeemed. Figure 66 shows the percentage of redemption in the various townships. From the map it is apparent that low percentages of redemption are found in the townships of the central and northwestern parts of the county. The areas of high redemption are found in the south end and northeastern corner of the county in which more land is in agricultural use. (See Fig. 66.)

Between 1928 and 1930, $20,557.10 in delinquent taxes were paid on 19,525 acres in the county, or an average of $1.05 per acre. This

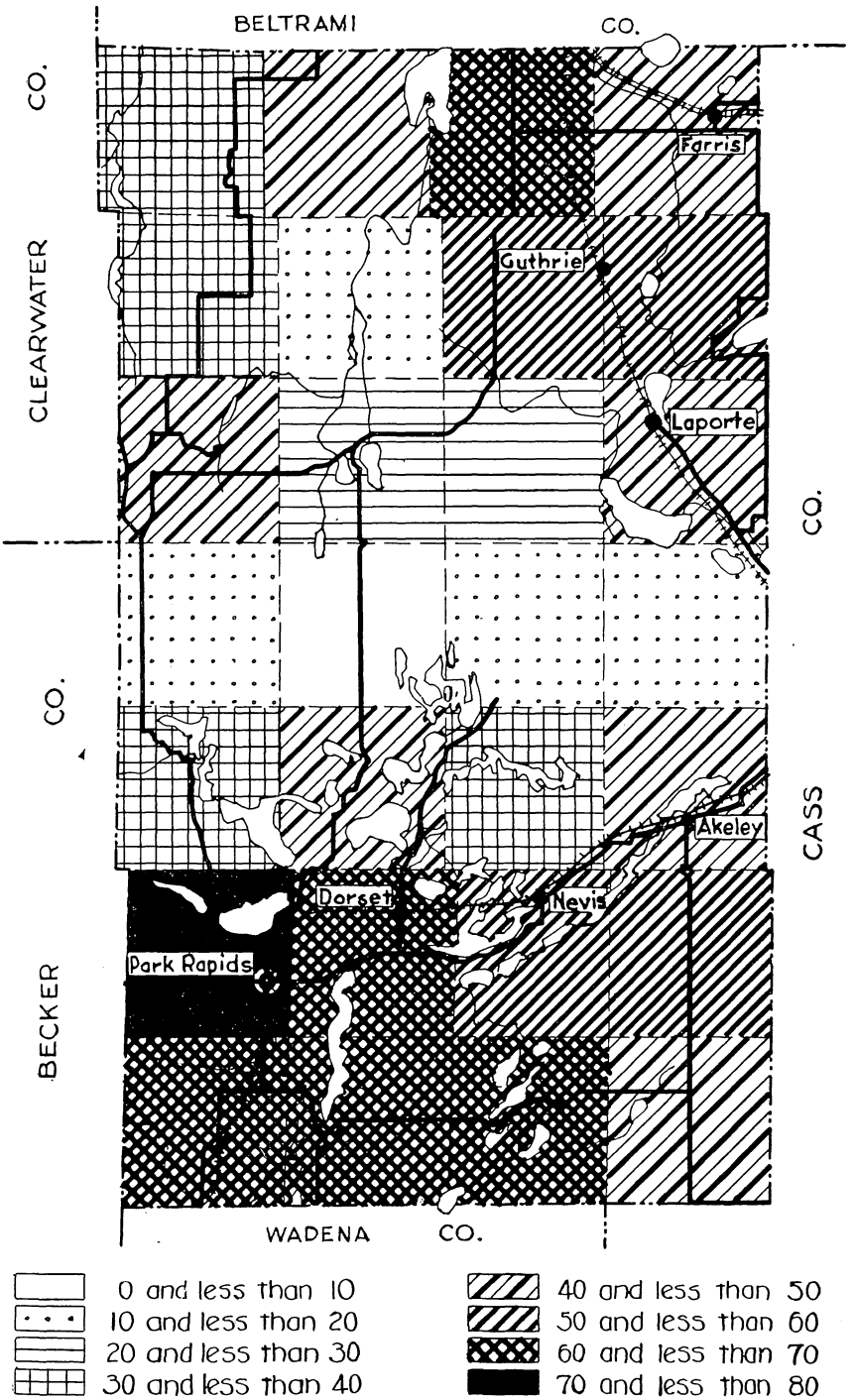

Fig. 66. Percentage of Tax-delinquent Land Redeemed by 1930; Average for County, 40.11 Per Cent

large payment of delinquent taxes may be due to the passage of a tax delinquency law by the legislature of 1927, which provided that land that had been delinquent for five years would revert to the state to be held in trust for the counties, townships, and school districts. Provision was made for waiving penalties and permitting settlement on more favorable conditions, provided the payment was made prior to November, 1929. This encouraged payment by owners who did not wish to lose title to their land.

The largest area of land redeemed during this period was in White Oak Township, $1,083.57 being paid on 1,652 acres of land. Other townships in which large areas were redeemed are: Straight River, with $1,504.59 on 1,589 acres; Mantrap, $1,203.41 on 1,297 acres; Todd, $1,059.24 on 1,194 acres; Hubbard, $1,071.78 on 1,120 acres, and Nevis, $1,554.00 on 1,002 acres. Henrietta had no acreage redeemed during this period, probably because it had no land in danger of reversion to the state. Thorpe paid $9.33 on 40 acres at this time. The heaviest average redemptions per acre were in Lake Emma Township, with $2.36; Akeley, $2.35; Nevis, $1.55; Schoolcraft, $1.53; Hart Lake, $1.38; Lakeport, $1.30, and Farden, $1.10.

The number of acres of land that had been delinquent and subsequently cancelled amounted to 13,107.35. The township having the largest area of this cancelled land was Lake Alice, with 4,013 acres. Steamboat River had 1,080 acres in this class. Other townships that had over 800 acres cancelled delinquent land were Badoura, Helga, and Lake Hattie.

The largest area of delinquent land had been redeemed prior to 1928. This area amounted to 136,273 acres scattered over every township of the county. Helga had the largest area, 8,406 acres; Akeley was next, with 7,810 acres; White Oak, 6,676 acres, and Farden, 6,603 acres. Clay had the least acres redeemed, 1,612. These figures bear out the statements made in discussing percentages of delinquency.

TYPE OF LAND OWNERSHIP AND TAX PAYMENT FOR 1930

An effort was made to determine, at least approximately, whether there were any differences in tax payment among the various types of ownership. Ownerships were classified on the basis of the information in the tax book of 1929. Subdivisons listed were counted and listed as to whether taxes for that year had been paid or not. Since this was done in July, payment of March and June settlements were taken as an indication that taxes would be paid for the year. Differences as to area in subdivisions were ignored, it being assumed that small areas would counterbalance the large areas. In the case of small lots in platted

resorts, a solid page of small lots listed under one owner were taken as one subdivision. The area involved in such a case is relatively small, and the total of all would scarcely equal the average subdivision. This measure cannot be taken too literally, but is indicative of how the various types of ownership pay taxes.

Water-power companies ranked highest in tax payment. Of all the subdivisions listed under that type, 99 per cent had paid their March to June settlements of 1929 taxes. Most of these subdivisions were located in Crow Wing and Nevis townships.

Mining companies ranked next, indicating payment on 80 per cent of subdivisions listed and failure to pay on 20 per cent. There were listed only 20 subdivisons under this ownership, however. This type of ownership is found only in Clay, Clover, Lakeport, Hendrickson, Hart Lake, and Farden townships.

The next group included the industrial companies, which indicated payment on 65 per cent of their subdivisions and non-payment on 35 per cent. The range is not particularly significant as the number of subdivisions listed per township varies widely. In Badoura, with the largest number of subdivisions listed (47), 45 were paid and 2 unpaid, or 96 per cent paid. Most of these subdivisions were owned by a grass-carpet company which presumably has derived some income from its holdings.

Little, if any, wire grass is now cut on these tracts for carpet purposes, because it no longer is adapted to that use. Drainage has ruined the bogs for wire-grass production, materially reducing the possible income to be derived from them. The only source of income from these bogs under present conditions is the meager tonnage of wire-grass hay of indifferent feeding value and hence low market value. There is small possibility that these bogs will be developed for agricultural use in the near future under the present economic conditions of agriculture. Similar land nearer markets is not being used, or is used indifferently, and can be purchased at rather low prices.

Individual land owners ranked next with 59 per cent of subdivisions paid. This class represents the largest number of subdivisions listed, 11,112 out of a total of 13,906. The highest number of divisions indicating payment of taxes was in Hubbard Township, with Lake Emma, Nevis, Todd, and Henrietta following in the order indicated. Summer residents may have had a part in raising the proportion of paid taxes in these townships because a number of summer homes were included. The range in number of divisions was from 695 in Hubbard to 49 in Lake Alice. The highest percentage paid was in Todd, with 82 per cent, Lake Emma second, Crow Wing third, Hubbard fourth, and Guthrie fifth.

Investment companies ranked next, indicating tax payment of 40 per cent of subdivisions listed and 60 per cent unpaid. The number of subdivisions listed was relatively small, 111 paid and 167 unpaid. They were found in all townships and ranged in number from 3 each in Thorpe, Clay, Lake Alice and Lake Emma to 26 in Nevis. The highest percentage indicating tax payment was 100 per cent in Crow Wing and the lowest was 11 in Lake George. Other high percentages were: Todd, 89 per cent; Badoura, 75 per cent; White Oak, 75 per cent, and Straight River, 69 per cent. Other low percentages were: Lake Hattie, 15 per cent; Fern, 16 per cent; Schoolcraft, 16 per cent, and Nevis, 19 per cent. The highest percentages indicating non-payment were in Lake Emma, Lake Alice, and Hart Lake, with 100 per cent. Other high percentages were Lake George, 89 per cent; Lake Hattie, 85 per cent; Fern, 84 per cent, and Schoolcraft, 84 per cent.

Land companies ranked next, indicating tax payment on 22 per cent of divisions listed and non-payment on 78 per cent of divisions listed, or 234 divisions paid and 816 not paid. Todd had 31 out of 33 divisions paid, or 94 per cent. Other high percentages of payment were Clover, 77; Henrietta, 66, and Lake Emma, 53. Townships indicating high non-payment on divisions listed were: Crow Wing, Straight River, White Oak, Steamboat River, and Rockwood. Other high percentages of non-payment were Mantrap, Lakeport, Hendrickson, Thorpe, and Fern.

Timber companies ranked lowest in tax payment indicated. Eleven per cent of the divisions listed indicated tax payment and 89 per cent non-payment. Expressed in numbers, taxes on 130 subdivisions were paid and on 999 tracts taxes were indicated as not paid. Those townships having a high percentage of non-payment indicated were: White Oak and Guthrie, 100 per cent; Lakeport, 98 per cent; Henrickson, 98 per cent, and Clover, 95 per cent. This high percentage of non-payment of tax indicates that the taxes levied may be out of proportion to the present income from land held by timber companies and suggests that even the small percentage that is now being paid may become delinquent before very long. This is true because timber companies no longer operate as timber companies but rather as land companies trying to sell their cut-over land. The tracts on which taxes are being paid likely are those considered best suited for agricultural development. If the companies become satisfied that these tracts can not be sold for farm use they are likely to stop paying taxes on them also.

Table 76 summarizes intention to pay 1929 taxes in 1930, as indicated by this approximate method.

Power companies paid taxes on 99 per cent of the area they owned. They owned only 1.14 per cent of the area of the county, but 28.24 per

Table 76

Type of Land Ownership and Tax Payment for 1930

Type of ownership	Number of subdivisions		Percentage		Percentage of area of county owned
	paid	unpaid	paid	unpaid	
Power companies	127	1	99	1	1.14
Mining companies	16	4	80	20	.16
Industrial companies	122	67	65	35	1.73
Individual owners	6,589	4,523	59	41	71.77
Investment and loan	111	167	40	60	2.71
Land companies	234	816	22	78	7.07
Timber companies	131	999	12	88	11.21
Miscellaneous	....	....	...	...	4.21
Total	7,329	6,577	52.7	47.3	100.00

cent of Crow Wing Township. This, no doubt, accounted for the low percentage of tax delinquency, 2 per cent, in that township. Mining companies paid taxes on 80 per cent of the area they owned, but they owned only one-sixth of one per cent of the area of the county. Industrial companies, such as railroads and grass-carpet companies, paid taxes on 65 per cent of the area they owned, but they owned less than 2 per cent of the area of the county. Individual owners paid taxes on 59 per cent of the area they owned, which was 72 per cent of the total area of the county. This type is most significant from the standpoint of area owned. Investment and loan companies paid taxes on 40 per cent of their tracts, and they owned 3 per cent of the area of the county. Land companies owned 7 per cent of the area of the county and paid taxes on 22 per cent of the tracts owned. Timber companies owned 11 per cent of the area of the county and paid taxes on 11 per cent of the tracts held by them.

MORTGAGE INDEBTEDNESS

The data on mortgage indebtedness on unplatted land were taken from the records of mortgages in the office of the county register of deeds in the fall of 1929 and were completed to June 1, 1930.

On June 1, 1930, there were in the county 1,835 mortgages representing an indebtedness of $2,232,186, involving 166,197 acres of land, with a true and full value of $3,938,686, according to assessment for tax purposes. The mortgage indebtedness was 57 per cent of the true and full value of the land involved. The average amount per mortgage was $1,216, and the average mortgage debt per acre was $13.43, with an average true and full value of $23.70. The owner's equity on an acre of his mortgaged farm averaged $10.27. The distribution of this mortgage indebtedness is shown in Figure 67, and Table 77 presents the statistical summary.

Table 77

Total Mortgage Indebtedness in Hubbard County

Township	Active							
	Number of mortgages	Total mortgage debt	Average amount of mortgage	Number of acres mortgaged	Average acre debt	Equalized valuation	Acre value	Per cent of value mortgaged
Akeley	87	$ 74,468.37	$ 855.96	6,141.89	$12.12	$ 150,959.35	$24.58	49.33
Arago	65	49,516.24	761.79	5,736.87	8.63	115,709.99	20.17	42.79
Badoura	62	61,096.26	985.42	6,714.78	9.10	107,785.00	16.05	56.68
Clay	24	13,269.80	552.91	1,922.66	6.90	30,731.58	15.98	43.18
Clover	32	22,600.97	706.28	3,826.55	5.91	58,435.20	15.27	38.68
Crow Wing Lake	56	76,410.06	1,364.47	6,231.51	12.26	120,658.95	19.36	63.33
Farden	74	84,714.09	1,144.79	6,600.74	12.83	135,543.98	20.53	62.50
Fern	50	43,649.04	872.98	5,548.32	7.87	119,245.42	21.49	36.60
Guthrie	90	124,088.10	1,378.76	7,752.81	16.01	169,053.56	21.81	73.40
Hart Lake	79	91,695.70	1,160.71	7,317.10	12.53	128,320.98	17.54	71.46
Helga	70	107,020.14	1,528.86	6,990.75	15.31	154,285.89	22.07	69.36
Hendrickson	57	54,067.05	948.54	4,277.05	12.64	60,502.12	14.15	89.36
Henrietta	89	150,854.74	1,695.00	9,104.46	16.57	344,067.49	37.79	43.84
Hubbard	89	198,098.27	2,225.82	8,668.93	22.85	344,565.83	39.75	57.49
Lake Alice	31	20,876.82	673.45	2,493.31	8.37	41,022.84	16.45	50.89
Lake Emma	52	32,889.60	632.49	3,449.26	9.54	68,910.00	19.98	47.73
Lake George	63	41,119.65	652.69	5,489.53	7.49	79,497.00	14.48	51.72
Lake Hattie	43	61,670.56	1,434.20	5,354.48	11.52	91,810.68	17.15	67.17
Lakeport	88	114,966.99	1,306.44	7,847.28	14.65	133,516.72	17.01	86.11
Mantrap	97	100,193.47	1,032.92	7,396.96	13.55	132,373.63	17.90	75.69
Nevis	109	133,344.76	1,223.35	7,430.14	17.95	183,844.08	24.74	72.53
Rockwood	54	47,142.67	873.01	4,463.92	10.56	73,765.64	16.52	63.91
Schoolcraft	39	29,663.62	760.61	3,760.35	7.89	53,455.36	14.22	55.49
Steamboat River District	29	22,094.40	761.88	3,050.05	7.24	41,727.96	13.68	52.95
Straight River	108	210,816.87	1,952.00	11,700.36	18.02	481,030.76	41.11	43.83
Thorpe	26	18,837.92	724.54	2,172.91	8.67	43,787.25	20.15	43.02
Todd	65	131,701.95	2,026.18	6,126.14	21.50	275,882.82	45.03	47.74
White Oak	107	115,318.77	1,077.75	8,627.82	13.37	198,196.32	22.97	58.18
Total, county	1,835	$2,232,186.88	$1,216.45	166,196.93	$13.43	$3,938,686.40	$23.70	56.67

Table 77—Continued

Total Mortgage Indebtedness in Hubbard County

Township	Foreclosed								
	Number of mortgages	Total mortgage debt	Average amount of mortgage	Number of acres mortgaged	Average acre debt	Equalized valuation	Acre value	Loan valuation ratio	Ratio of no. foreclosed to no. active
Akeley	18	$20,823.65	$1,156.87	1,832.50	$11.36	$ 40,408.70	$22.05	21.53	20.69
Arago	14	9,453.22	675.23	1,375.95	6.87	27,452.50	19.95	34.43	21.53
Badoura	27	20,136.95	745.81	3,169.95	6.35	55,196.25	17.41	36.48	43.55
Clay	17	7,069.82	415.87	1,760.00	4.02	26,056.14	14.80	27.13	70.83
Clover	13	15,229.47	1,171.50	2,370.38	6.42	38,616.00	16.29	39.44	40.63
Crow Wing Lake	23	34,155.71	1,485.03	3,650.30	9.36	53,736.75	14.72	63.56	41.07
Farden	29	24,789.55	854.81	2,666.72	9.30	48,675.77	18.25	50.93	39.19
Fern	14	17,708.68	1,264.91	2,788.95	6.35	47,796.27	17.14	37.05	28.00
Guthrie	14	20,078.72	1,434.19	1,541.33	13.03	31,533.33	20.46	63.67	15.56
Hart Lake	21	29,407.12	1,400.34	2,532.58	11.61	37,640.46	14.86	78.13	26.58
Helga	22	25,287.60	1,149.44	2,353.70	10.74	49,618.47	21.08	50.96	31.42
Hendrickson	20	16,178.35	808.92	2,119.41	7.63	30,857.16	14.56	52.43	35.09
Henrietta	25	37,287.21	1,491.49	2,708.76	13.77	86,484.55	31.93	43.11	28.09
Hubbard	20	52,717.52	2,635.88	2,736.29	19.27	102,870.99	37.60	51.25	22.47
Lake Alice	21	14,587.91	694.66	2,995.15	4.87	39,518.01	13.19	36.91	67.74
Lake Emma	16	10,543.97	659.00	1,341.73	7.86	24,393.00	18.18	43.23	30.77
Lake George	27	19,867.81	735.84	3,779.08	5.26	47,407.30	12.54	41.91	42.86
Lake Hattie	25	26,177.39	1,047.10	4,080.81	6.41	61,252.92	15.01	42.74	58.14
Lakeport	21	15,910.07	757.62	1,651.49	9.63	23,669.64	14.33	67.22	23.86
Mantrap	10	8,250.00	825.00	960.00	8.59	16,713.48	17.41	49.36	10.31
Nevis	30	36,087.42	1,202.91	2,522.44	14.31	58,477.14	23.18	61.71	27.52
Rockwood	22	21,484.30	976.56	2,535.62	8.47	43,823.88	17.28	49.02	40.74
Schoolcraft	15	12,267.73	817.85	1,707.50	7.18	25,236.48	15.37	48.61	38.46
Steamboat River District	6	6,211.51	1,035.25	818.01	8.59	9,460.50	11.57	65.66	20.69
Straight River	33	54,559.60	1,653.32	3,289.64	16.59	127,725.72	38.83	42.72	30.56
Thorpe	6	1,430.00	238.33	280.00	5.11	3,645.00	13.02	39.23	16.67
Todd	24	76,162.52	3,173.44	2,996.15	25.42	133,323.48	44.50	57.13	36.92
White Oak	30	37,955.93	1,265.20	3,191.96	11.89	71,900.70	22.53	52.79	28.04
Total, county	563	$671,819.73	$1,193.29	65,756.40	$10.22	$1,363,490.59	$20.74	48.23	30.68

Table 77—Continued

Total Mortgage Indebtedness in Hubbard County

Township	Satisfied (Nov. 1, 1929 to June 1, 1930)								
	Number of mortgages	Total mortgage debt	Average amount of mortgage	Number of acres mortgaged	Average acre debt	Equalized valuation	Acre value	Loan valuation ratio	Ratio of no. foreclosed to no. active
Akeley	5	$ 5,260.00	$1,052.00	368.70	$14.27	$ 10,532.85	$28.57	49.94	5.75
Arago	1	400.00	400.00	160.00	2.50	3,615.39	22.60	11.06	1.54
Badoura	1	3,000.00	3,000.00	160.00	18.75	3,581.25	22.38	83.77	1.61
Clay	...	.....	.....	.....	....	.....	....	....	....
Clover	...	.....	.....	.....	....	.....	....	....	....
Crow Wing Lake	5	1,425.50	285.10	130.50	10.92	2,166.75	16.60	65.79	8.93
Farden	3	1,150.00	383.33	215.50	5.34	5,092.23	23.63	22.58	4.05
Fern	2	600.00	300.00	120.00	5.00	1,810.28	15.09	33.14	4.00
Guthrie	5	7,712.43	1,542.49	480.00	16.07	12,225.34	25.47	63.09	5.56
Hart Lake	4	7,912.00	1,978.00	496.08	15.95	7,664.13	15.45	103.23	5.06
Helga	4	9,280.00	2,320.00	480.00	19.33	11,173.14	23.28	83.06	5.71
Hendrickson	3	1,916.75	638.92	240.00	7.99	4,162.08	17.34	46.05	5.26
Henrietta	7	7,937.50	1,133.93	527.52	15.05	32,732.71	62.05	24.25	7.87
Hubbard	11	16,290.00	1,480.91	1,087.61	14.98	41,104.80	37.79	39.63	12.36
Lake Alice	1	1,053.35	1,053.35	166.09	6.34	3,899.58	23.48	27.01	3.23
Lake Emma	5	3,466.60	693.32	238.70	14.52	4,443.00	18.61	78.02	9.62
Lake George	3	2,700.00	900.00	438.93	6.15	5,391.90	12.28	50.08	4.76
Lake Hattie	2	2,169.87	1,084.93	233.75	9.28	4,280.01	18.31	50.70	4.65
Lakeport	8	5,500.16	687.52	494.48	11.12	12,016.12	24.30	45.77	9.09
Mantrap	4	1,735.40	433.85	240.00	7.23	3,727.91	15.53	46.55	4.12
Nevis	2	1,400.00	700.00	160.00	8.75	2,624.40	16.40	53.35	1.83
Rockwood	4	1,913.07	478.29	360.00	5.31	5,887.56	16.35	32.49	7.41
Schoolcraft	...	.....	.....	.....	....	.....	....	....	....
Steamboat River District	1	300.00	300.00	80.00	3.75	1,405.56	17.57	21.34	3.45
Straight River	7	4,547.64	649.66	360.00	12.63	13,263.78	36.84	34.29	6.48
Thorpe	...	.....	.....	.....	....	.....	....	....	....
Todd	4	6,000.00	1,500.00	440.00	13.64	24,886.20	56.56	24.11	6.15
White Oak	3	2,750.00	916.67	360.92	7.62	7,554.24	20.93	36.40	2.80
Total, county	95	$96,420.27	$1,014.95	8,038.78	$11.99	$224,241.21	$27.89	43.00	5.18

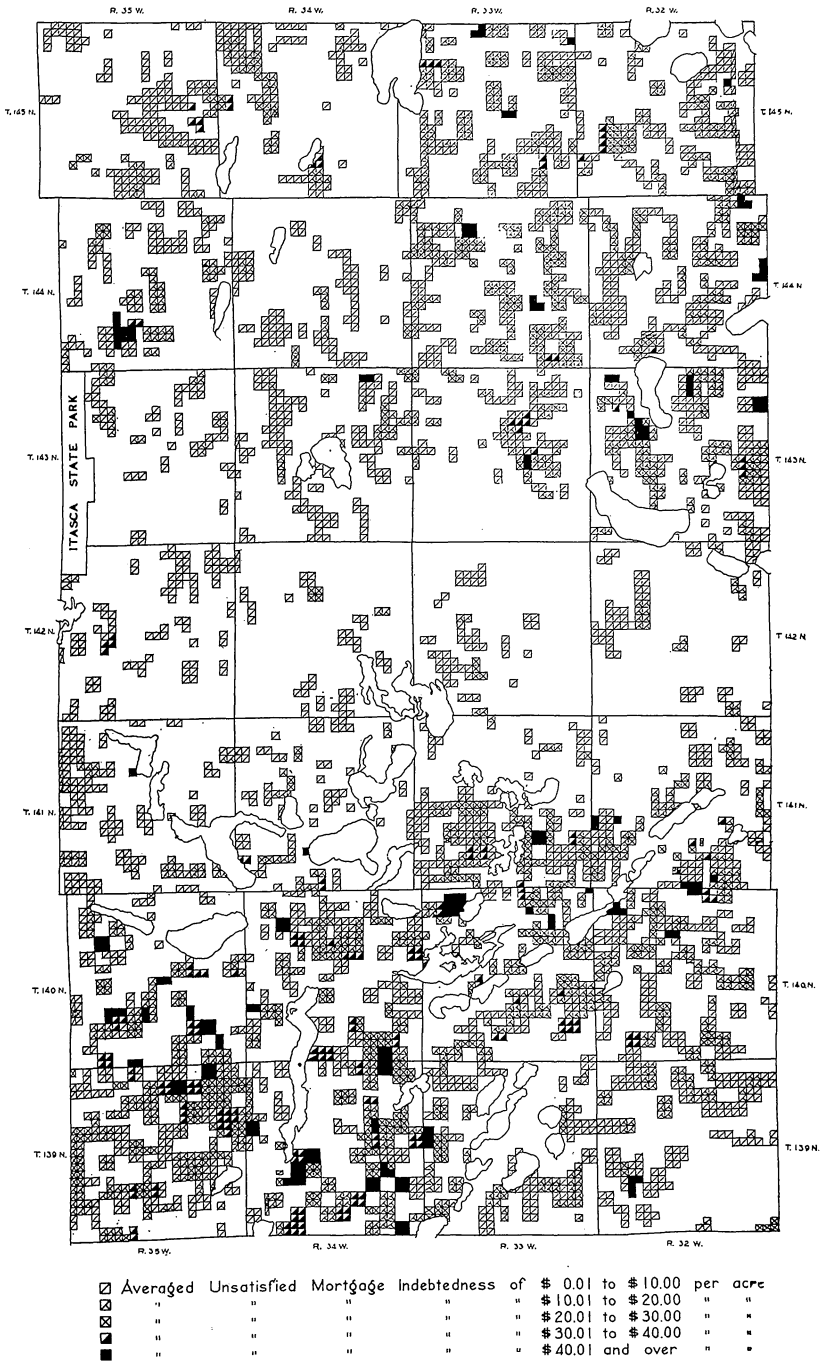

Fig. 67. Unsatisfied Mortgage Indebtedness in Hubbard County, January 1930

The amount of mortgage indebtedness per township ranged from $13,270 in Clay Township to $210,817 in Straight River. The townships having over $100,000 each in indebtedness were Straight River, Hubbard, Henrietta, Todd, Nevis, Guthrie, White Oak, Lakeport, Helga, and Mantrap, in the order indicated. Six townships—Clay, Thorpe, Lake Alice, Steamboat River, Clover, and Schoolcraft—each had less than $30,000 in mortgage indebtedness per township. The high indebtedness in the former group may be attributed to the more general agricultural development in that group and the resulting need for loans for operation of farms. A second explanation may lie in the fact that active agricultural land is accepted more readily as security for loans than the relatively idle, undeveloped land covering the larger part of the area of the townships of the latter group.

The average amount of mortgage for the county as a whole was $1,216. Clay Township with $553 had the smallest average mortgage, and Hubbard had the largest average mortgage of $2,226. The average mortgage in 10 townships was above the average for the county, and in only 14 townships was the average mortgage above $1,000. The 10 townships in which the average mortgage was above the county average were Hubbard, $2,226; Todd, $2,026; Straight River, $1,952; Henrietta, $1,695; Helga, $1,529; Lake Hattie, $1,434; Guthrie, $1,379; Crow Wing, $1,364; Lakeport, $1,306, and Nevis, $1,223. All of these townships rank relatively high in agricultural development except Lake Hattie, where the high average mortgage was due to an abnormal loan on undeveloped land.

Townships with relatively small average mortgage amounts were Clay, $553; Lake Emma, $632; Lake George, $653; Lake Alice, $673; Clover, $706; Thorpe, $725; Schoolcraft, $761; Arago, $762; Steamboat River, $762; Akeley, $856; Fern, $873; Rockwood, $873; Hendrickson, $949, and Badoura, $985. The agricultural development of these townships may be said to vary directly with the average size of mortgage. In general, the average size of mortgage debt, as well as total active mortgage indebtedness, apparently is associated with definite land use such as agriculture and perhaps recreation.

The loan valuation ratio, as indicated by the ratio of mortgage indebtedness to equalized true and full value of the mortgaged lands, for the county as a whole and for the various townships also is significant. As mentioned above, for the county as a whole 57 per cent of the true and full value was covered by mortgage indebtedness. In the townships the range was from 37 per cent in Fern to 89 per cent in Hendrickson. If valuation for taxation is assumed to represent accurately the proportionate ability of property to produce income, and hence its abil-

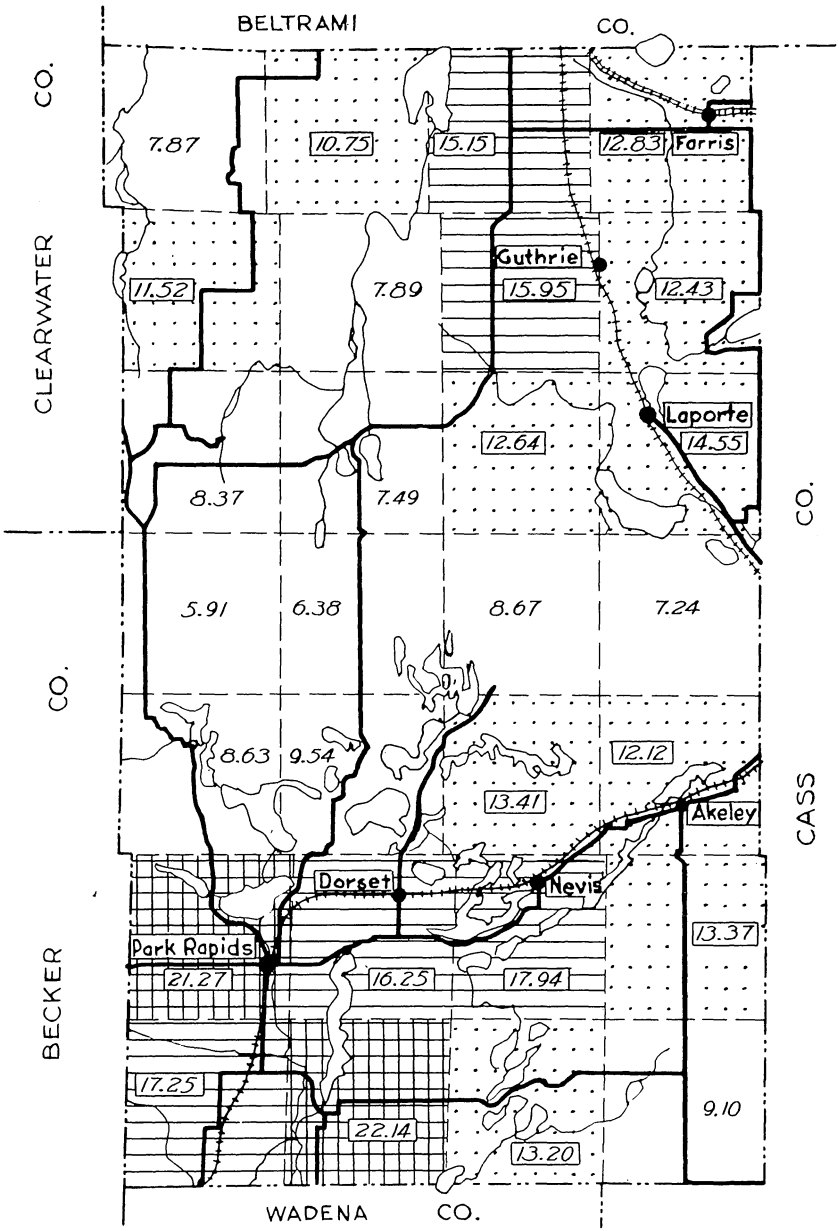

Fig. 68. Average Debt Per Mortgaged Acre

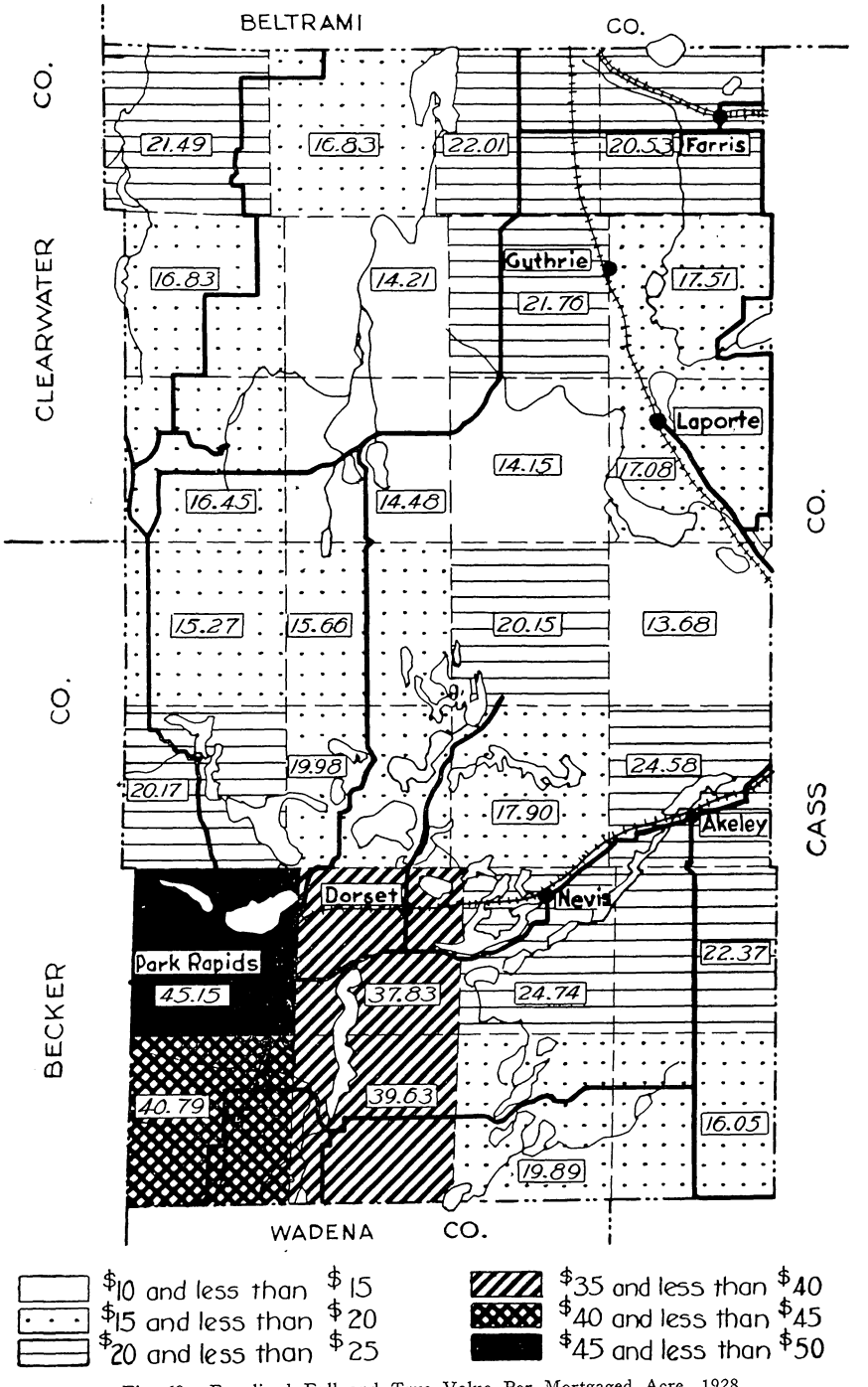

Fig. 69. Equalized Full and True Value Per Mortgaged Acre, 1928

ity to pay taxes, and if the judgment of value as security for loans was accurate, the ratio of loans to full value would have a rather fixed and narrow range. If we assume that, the ratio of actual loan to total loan value, for townships or a county as a whole, is uniform. However, both are subject to human fallibility, and the range is wide. The low ratio of 37 in Fern was based on an average loan of $7.87 per acre on land assessed for taxation at true and full value of $21.49. In Hendrickson Township, on the other hand, the ratio of 89 of loan to full value was based on an average loan of $12.64 per acre valued at $14.15. The question is whether the average valuation of the mortgaged land in the two townships is truly representative of their true relative value or ability to produce income.

The average mortgage debt per acre varied from $5.91 in Clover Township to $22.85 per acre in Hubbard Township. Nineteen townships had less than the average debt of $13.43 per acre, for the county, and nine had more. Those above the average were located in the south end and northeast corner of the county. Figure 68 shows the average debt per mortgaged acre by townships.

The equalized true and full value per acre for the mortgaged land for the county was $23.70 in 1928 and is presented in Figure 69. The range by townships extended from $13.68 for Steamboat River to $45.03 per acre in Todd Township. Only six townships had an average true and full value of mortgaged area above the average and the balance, or 22 townships, had a value of less than the average for the county. The six townships above the average, with their average value, were: Todd, $45.03; Straight River, $41.11; Hubbard, $39.75; Henrietta, $37.79; Nevis, $24.74, and Akeley, $24.58. Figure 69 shows the average full and true value per mortgaged acre by townships in 1928.

The number of mortgages per township varied from 109 in Nevis to 26 in Thorpe. The average per township was 65. Fourteen townships had more mortgages than the average number for the county. They were the townships with relatively more agricultural development.

FORECLOSED MORTGAGES

Five hundred sixty-three mortgages amounting to $671,819.73 and involving 65,756.40 acres had been foreclosed in the county. The foreclosed mortgages are not as significant as might at first appear, since all are not forced foreclosures. Some mortgages are foreclosed to settle estates. There are other examples of so-called friendly foreclosures. There is no way of identifying this type of foreclosure. The average amount of foreclosed mortgage was $1,193, and the average loan valua-

tion ratio was 48. Both of these were smaller than the corresponding values for active mortgages.

The ratio of number of foreclosed mortgages to total mortgages may be indicative of relative income-producing ability among townships. There were 563 mortgages foreclosed to 1,835 active at the time, for the county as a whole, or a ratio of 31 per cent. Among townships the range of ratios extended from 10 for Mantrap to 71 for Clay. The lower the ratio, the lower the relative mortality among mortgages. Fourteen townships had a ratio of less than the average for the county, and 14 had a ratio higher than the average. Those with the highest ratio were Clay, 71; Lake Alice, 68; Lake Hattie, 58; Badoura, 44; Lake George, 43; Crow Wing, 41; Rockwood, 41; Clover, 41; Farden, 39; Schoolcraft, 38; Todd, 37; Hendrickson, 35; Helga, 31, and Lake Emma, 31.

The loan valuation ratio varied from 22 in Akeley to 67 in Lakeport. This was a narrower range than was found in active mortgages but was a larger percentage of the average. Fifteen townships had a loan valuation ratio higher than the average for the county, and in 13 it was lower.

SATISFIED MORTGAGES

Ninety-five mortgages were satisfied from October, 1928, to June, 1930. The average amount per mortgage was $1,015, and the loan valuation ratio was 43. Both were lower than either active or foreclosed mortgages, indicating that chiefly smaller mortgages and those representing a smaller proportion of valuation were being paid or satisfied.

The ratio of number of satisfied mortgages to active mortgages may give some indication of relative income-producing ability among the townships during the period studied. Low ratios may indicate relative inability to pay encumbrances during that time, other things being equal. The ratio of satisfied mortgages to active was 5 per cent. The ratio of satisfied mortgages to active cannot be compared with the ratio of foreclosed mortgages as the time involved was not the same. The range extended from no mortgages satisfied in Thorpe, Schoolcraft, Clay, and Clover townships to 12 per cent in Hubbard. Twelve townships were below the average ratio for the county, and 16 were above. The lowest ratios were in the central part of the county, while some ratios below the ratio for the county were in the northeast corner where the number of mortgages was relatively high, due presumably to greater need for agricultural development. This low ratio may have been due to long-term mortgages with the state rural credit or federal

farm loan system, which were drawn within the last 15 years and hence were not yet due. Table 78 shows the ratios of numbers of foreclosed and satisfied mortgages to the number of active mortgages on all land outside platted villages.

Table 78

Ratios of Total Numbers of Satisfied and Foreclosed Mortgages to Total Number of Active Mortgages

Township	Active mortgages	Foreclosed mortgages	Ratio of foreclosed to active	Satisfied mortgages	Ratio of satisfied to active
Akeley	87	18	20.68	5	5.75
Arago	65	14	21.53	1	1.54
Badoura	62	27	43.55	1	1.61
Clover	24	17	70.83	..	...
Clay	32	13	40.63	..	...
Crow Wing	56	23	41.07	5	8.93
Farden	74	29	39.19	3	4.05
Fern	50	14	28.00	2	4.00
Guthrie	90	14	15.56	5	5.56
Hart Lake	79	21	26.58	4	5.06
Helga	70	22	31.42	4	5.71
Hendrickson	57	20	35.09	3	5.26
Henrietta	89	25	28.09	7	7.87
Hubbard	89	20	22.47	11	12.36
Lake Alice	31	21	67.74	1	3.23
Lake Emma	52	16	30.77	5	9.62
Lake George	63	27	42.86	3	4.76
Lake Hattie	43	25	58.14	2	4.65
Lakeport	88	21	23.86	8	9.09
Mantrap	97	10	10.31	4	4.12
Nevis	109	30	27.52	2	1.83
Rockwood	54	22	40.74	4	7.41
Schoolcraft	39	15	38.46	..	...
Straight River	108	33	30.56	7	6.48
Todd	29	6	20.69	1	3.45
Thorpe	26	6	16.67	..	...
White Oak	65	24	36.92	4	6.15
Steamboat River	107	30	28.04	3	2.80
Total, county	1,835	563	30.68	95	5.18

MORTGAGE INDEBTEDNESS ON AGRICULTURAL LAND

Of the total mortgaged area of 166,197 acres within the county, 117,420 acres, or 71 per cent, were dedicated to agricultural use. This area carried a mortgage debt of $1,820,697, or 82 per cent of the total mortgage debt of $2,232,187. That is, 71 per cent of the mortgaged area was agricultural and carried 82 per cent of the total mortgage debt. Each acre mortgaged carried an average debt of $15.52, which was 57.50 per cent of the equalized true and full value per acre of $27.04, as compared with an average debt of $13.43 with a full value of $23.70 for all land mortgaged, and a loan valuation ratio of 57. Of the 1,835 mortgages in the county, 1,358, or 74 per cent, were on land in agriculture. From this it is apparent that nearly three-fourths of the mortgages were on agricultural land. The average mortgage debt on this land was $1,340.72 as compared with $1,216.45 for all land mortgaged. Thus, as might be expected, the average debt was larger and both the

Table 79

Mortgage Indebtedness on Farm Land in Hubbard County

Township	Active							
	Number of mortgages	Total mortgage debt	Average amount of mortgage	Number of acres mortgaged	Average acre debt	Equalized valuation	Acre value	Loan valuation ratio
Akeley	78	$ 68,430.00	$ 877.31	5,245.61	$13.05	$ 133,540.30	$25.46	51.24
Arago	42	29,991.38	714.08	3,383.42	8.86	70,720.42	20.90	42.41
Badoura	40	44,567.68	1,114.19	4,280.02	10.41	74,778.75	17.47	59.60
Clay	11	8,347.93	758.90	835.56	9.99	14,334.87	17.16	58.24
Clover	15	6,106.07	407.07	1,090.83	5.60	18,988.80	17.41	32.16
Crow Wing Lake	39	54,852.21	1,406.47	4,184.30	13.11	94,305.60	22.54	58.16
Farden	60	75,709.64	1,261.83	5,276.92	14.35	114,287.03	21.66	66.25
Fern	41	35,713.48	871.06	3,962.49	9.01	92,879.83	23.44	38.45
Guthrie	69	101,659.09	1,473.32	5,578.31	18.22	131,119.34	23.51	77.53
Hart Lake	65	76,884.97	1,182.85	5,180.35	14.84	99,605.40	19.23	77.19
Helga	60	94,128.69	1,568.81	5,919.77	15.90	134,313.63	22.69	70.08
Hendrickson	36	35,550.07	987.50	2,463.72	14.43	35,168.88	14.27	101.08
Henrietta	79	140,298.16	1,775.93	8,239.66	17.03	323,396.40	39.25	43.38
Hubbard	78	190,619.50	2,443.84	7,728.65	24.66	327,165.49	42.33	58.26
Lake Alice	11	7,598.80	690.80	713.75	10.65	16,111.26	22.57	47.16
Lake Emma	34	18,935.26	556.92	1,846.11	10.26	38,817.00	21.03	48.78
Lake George	33	27,763.82	841.33	2,449.92	11.33	34,841.70	14.22	79.69
Lake Hattie	27	30,436.77	1,127.29	2,618.55	11.62	53,421.12	20.40	56.98
Lakeport	62	91,184.56	1,470.72	5,026.70	18.14	91,351.52	18.17	99.82
Mantrap	77	85,281.60	1,107.55	5,775.09	14.77	108,333.61	18.76	78.72
Nevis	91	116,386.77	1,278.98	6,106.74	19.06	155,694.96	25.50	74.75
Rockwood	35	35,768.24	1,021.95	2,941.00	12.16	51,546.68	17.53	69.39
Schoolcraft	18	12,200.79	677.82	1,233.00	9.90	19,822.08	16.08	61.55
Steamboat River District	2	950.00	475.00	156.96	6.05	2,407.26	15.34	39.46
Straight River	95	194,630.43	2,048.74	10,496.21	18.54	457,861.34	43.62	42.51
Thorpe	14	12,449.98	889.28	1,316.50	9.46	32,262.30	24.51	38.59
Todd	60	129,383.95	2,156.40	5,923.64	21.84	265,675.68	44.85	48.70
White Oak	86	99,867.35	1,161.25	7,446.63	13.41	182,641.32	24.53	54.68
Total, county	1,358	$1,825,697.19	$1,342.72	117,420.41	$15.52	$3,175,392.57	$27.04	57.50

Table 79—Continued

Mortgage Indebtedness on Farm Land in Hubbard County

Township	Foreclosed							
	Number of mortgages	Total mortgage debt	Average amount of mortgage	Number of acres mortgaged	Average acre debt	Equalized valuation	Acre value	Loan valuation ratio
Akeley	17	$ 17,823.65	$1,048.45	1,632.50	$10.92	$ 36,486.05	$22.35	48.85
Arago	8	6,718.76	839.85	859.97	7.81	20,016.00	23.28	33.57
Badoura	15	14,867.55	991.17	1,973.55	7.53	38,107.50	19.31	39.01
Clay	5	2,459.52	491.90	560.00	4.39	8,599.47	15.36	28.60
Clover	10	12,079.47	1,207.95	1,650.38	7.32	27,480.00	16.65	43.96
Crow Wing Lake	10	21,236.09	2,123.61	1,468.38	14.46	26,859.60	18.29	79.06
Farden	20	18,082.47	904.12	1,461.48	12.37	31,244.07	21.38	57.87
Fern	9	5,315.38	590.60	723.75	7.34	13,495.80	18.65	39.39
Guthrie	8	13,813.78	1,726.72	782.14	17.66	17,336.31	22.17	79.68
Hart Lake	16	23,073.93	1,422.12	1,721.15	13.41	29,548.29	17.17	78.09
Helga	13	20,782.60	1,598.66	1,751.20	11.87	38,202.12	21.81	54.40
Hendrickson	10	6,445.40	644.54	840.00	7.67	11,842.44	14.10	54.43
Henrietta	23	35,507.21	1,543.79	2,433.12	14.59	81,364.52	33.44	43.64
Hubbard	19	50,217.52	2,643.03	2,576.29	19.49	100,099.53	38.85	50.17
Lake Alice	6	4,820.40	803.40	400.00	12.05	5,840.10	14.60	82.54
Lake Emma	5	5,131.60	1,026.32	320.00	16.04	6,690.00	20.91	76.71
Lake George	12	7,968.82	664.07	1,228.44	6.49	18,376.20	14.96	43.36
Lake Hattie	7	9,189.49	1,312.78	1,091.65	8.42	18,315.42	16.78	50.17
Lakeport	9	4,263.02	473.67	557.42	7.65	8,325.00	14.93	51.21
Mantrap	10	7,650.00	765.00	800.00	9.56	14,671.26	18.34	52.14
Nevis	22	30,355.20	1,379.78	2,093.90	14.50	51,911.28	24.79	58.48
Rockwood	7	2,400.00	342.85	596.00	4.03	9,587.28	16.09	25.03
Schoolcraft	4	2,358.72	589.68	633.00	3.73	10,721.28	16.94	22.00
Steamboat River District	...	.....	.....	.....	....	.....	....	....
Straight River	26	52,339.60	2,013.06	3,049.64	17.16	122,604.12	40.20	42.69
Thorpe	1	500.00	500.00	80.00	6.25	1,210.95	15.14	41.29
Todd	24	76,162.52	3,173.44	2,996.15	25.42	133,323.48	44.50	57.13
White Oak	25	37,044.35	1,481.77	2,864.96	12.93	66,289.92	23.14	55.88
Total, county	341	$488,607.50	$1,432.87	37,145.07	$13.15	$948,547.99	$25.54	51.51

Table 79—Continued

Mortgage Indebtedness on Farm Land in Hubbard County

Township	Satisfied (Nov. 1, 1929 to June 1, 1930)							
	Number of mortgages	Total mortgage debt	Average amount of mortgage	Number of acres mortgaged	Average acre debt	Equalized valuation	Acre value	Loan valuation ratio
Akeley	3	$ 3,940.00	$1,313.33	320.00	$12.31	$ 8,286.90	$25.90	47.54
Arago	1	400.00	400.00	160.00	2.50	3,615.39	22.60	11.06
Badoura	1	3,000.00	3,000.00	160.00	18.75	3,581.25	22.38	83.77
Clay	...	.....	.....	.....	....	.....	....	....
Clover	...	.....	.....	.....	....	.....	....	....
Crow Wing Lake	6	1,425.50	237.58	130.50	10.92	2,166.75	16.60	65.79
Farden	3	1,150.00	383.33	215.50	5.34	5,092.23	23.63	22.58
Fern	2	600.00	300.00	120.00	5.00	1,810.28	15.09	33.14
Guthrie	5	7,712.43	1,542.49	480.00	16.07	11,225.34	23.39	68.71
Hart Lake	4	7,912.00	1,978.00	496.08	15.95	7,664.13	15.45	103.23
Helga	3	8,000.00	2,666.67	320.00	25.00	8,087.64	25.27	98.92
Hendrickson	3	1,916.75	638.92	240.00	7.99	4,162.08	17.34	46.05
Henrietta	3	2,700.00	900.00	213.38	12.65	8,463.70	39.66	31.90
Hubbard	7	15,290.00	2,184.29	932.85	16.39	37,139.64	39.81	41.17
Lake Alice	1	1,053.35	1,053.35	166.09	6.34	3,899.58	23.48	27.01
Lake Emma	3	3,166.60	1,055.53	237.70	13.32	4,368.00	18.38	72.50
Lake George	1	1,700.00	1,700.00	198.93	8.55	2,151.90	10.82	79.00
Lake Hattie	2	1,720.27	860.14	193.75	8.88	3,730.41	19.25	46.11
Lakeport	4	3,500.07	875.02	272.06	12.87	5,819.36	21.39	60.15
Mantrap	3	1,135.40	378.47	160.00	7.10	2,479.55	15.50	45.79
Nevis	2	1,400.00	700.00	160.00	8.75	2,624.40	16.40	53.35
Rockwood	3	1,513.07	504.36	320.00	4.73	5,201.28	16.25	29.09
Schoolcraft	...	.....	.....	.....	....	.....	....	....
Steamboat River District	1	300.00	300.00	80.00	3.75	1,405.56	17.57	21.34
Straight River	6	4,547.64	757.94	360.00	12.63	13,263.78	36.84	34.29
Thorpe	...	.....	.....	.....	....	.....	....	....
Todd	4	6,000.00	1,500.00	440.00	13.64	24,886.20	56.56	24.11
White Oak	3	2,750.00	916.67	360.92	7.62	7,554.24	20.93	36.40
Total, county	74	$82,833.08	$1,134.70	6,737.76	$12.29	$178,679.59	$26.52	46.36

average debt per acre and the true and full value per acre were higher on land in agricultural use. (See Table 79.)

The active mortgages on farm land averaged $1,342.72 and ranged from $475 in Steamboat River to $2,444 in Hubbard. In eight townships the average mortgage was higher than the county average.

The number of mortgages on land in agricultural use in the various townships ranged from 2 in Steamboat River to 95 in Straight River. The average per township was 48. Thirteen townships had more than the average number, and 15 had less. The townships with the largest number of mortgages were those in which the agricultural development was most extensive.

The larger amount per mortgage and the number of acres involved were likewise in the townships where agriculture was more extensive. The same may be said of mortgage debt per acre. The average debt per acre for the county was $15.52, ranging from $6.05 in Steamboat River to $24.66 in Hubbard. Eight townships were above the average in this respect, five of them being in the south end and three in the northeast corner.

The ratio of mortgage debt to true and full value of farm land was 57.50, which was only slightly higher than the ratio of debt to value of all mortgaged land in the county which was 56.67. Fifteen townships were above and 12 below the average in this regard. The range was considerably wider—32 per cent in Clover to 101 in Hendrickson. Clover Township had a relatively high value per acre, $17.41, and a low debt per acre, $5.60. Hendrickson, on the other hand, had a lower value per acre, $14.28, and a much higher debt per acre, $14.70, which accounts for the unusual ratio. There can be no question that the debt per acre was out of proportion to the valuation in this case. Lakeport, likewise, had a high ratio of 99.8, representing the relation between an average debt per acre of $18.14 and an average valuation of $18.17. This ratio likewise was unusual and represented a high loan or a low valuation policy. Lake George was the next highest, tho considerably lower, with 80 per cent. The rather striking fact is that the four townships with the greatest agricultural development, Hubbard, Todd, Henrietta, and Straight River, had a ratio of debt to valuation very near or below the average. Hubbard was the highest, with 58 per cent, and Straight River lowest, with 43 per cent. The highest ratios were found in relatively poorly developed agricultural townships. Some of the low ratios were found in the poorer agricultural townships, due to relatively high valuations rather than very large loans. Steamboat River, with a ratio of 39, had an average loan per acre of

$6.05 on an average acre valuation of $15.35. Thorpe, with a loan valuation ratio of 39, had an average loan of 9.46 and an average acre valuation of $24.51. Clover Township, with the lowest ratio, 32.16, had an average debt of $5.60 and an average acre valuation of $17.41. In any of these latter cases, the low ratio may have been largely due to a relatively high valuation.

Three hundred forty-one mortgages had been foreclosed on land in agricultural use. Here again friendly foreclosure must be borne in mind. The ratio of number of foreclosed mortgages to the number of active mortgages was 25 per cent or somewhat less than the corresponding ratio of 31 for total mortgaged land. The average amount per foreclosed mortgage was $1,433 or somewhat more than the average active mortgage of $1,341. The ratio of mortgage debt to valuation was 52 per cent, somewhat lower than the corresponding ratio of 57 per cent for active mortgages. The loan valuation ratio on foreclosed mortgages was 5 per cent lower, indicating that agriculture had difficulty in paying mortgages even on a lower loan valuation ratio.

The number of foreclosed mortgages ranged from none in Steamboat River to 26 in Straight River. The average number per township was 12. Eleven townships had more foreclosures than the average, and 17 had less. This is not as significant as the ratio of number of foreclosed to active mortgages on agricultural land. The ratio of number of foreclosed mortgages to number of active mortgages on farm land in the county was 25 per cent. This ranged from 7 in Thorpe Township to 67 in Clover Township. The average ratio for the county was 25.11. Townships having a ratio of less than the average of foreclosed to active mortgages would be said to have a favorable ratio. Fourteen townships had ratios below the average and fourteen had ratios above. Low percentages were not confined to non-agricultural townships. Steamboat River had no foreclosures, but it had only two active mortgages on farm land. Thorpe had 1 foreclosure to 14 active, or a ratio of 7 per cent. Todd, on the other hand, an agricultural township, had 24 foreclosed mortgages to 60 active, or a ratio of 40 per cent. Clover, with little agricultural development, had 10 foreclosed mortgages to 15 active, or a ratio of 67 per cent. Obviously, foreclosure cannot be attributed to any specific use of land, except unprofitable use.

Table 80 indicates the ratio of number of foreclosed and satisfied mortgages to the number of active mortgages on agricultural land.

Seventy-four mortgages on farm land, or a ratio of 5 per cent, were satisfied from October, 1929 to June, 1930. The number of mortgages satisfied ranged from none in four townships to seven in Hubbard. The ratio ranged from 2 in Nevis to 50 in Steamboat River. Ratios

higher than the average were considered favorable ratios. Twelve townships had ratios greater than the average, and 12 had ratios less than the average. Here again, mortgage satisfaction as expressed by this ratio cannot be considered as representative of the whole township or the income-producing ability of the township. Steamboat River had a ratio of 50.00, i.e., one mortgage was satisfied to the two that were active in the township. This ratio could not be considered as representative of all land or even all land in agricultural use in the township.

Table 80

Ratios of Number of Foreclosed and Satisfied Mortgages to Number of Active Mortgages on Land in Agricultural Use*

Township	Active mortgages	Foreclosed mortgages	Ratio of foreclosed to active	Satisfied mortgages	Ratio of satisfied to active
Akeley	78	17	21.79	3	3.85
Arago	42	8	19.05	1	2.38
Badoura	40	15	37.50	1	2.50
Clay	11	5	45.45	..	...
Clover	15	10	66.67	..	...
Crow Wing	39	10	25.64	6	15.38
Farden	60	20	33.33	3	5.00
Fern	41	9	21.95	2	4.88
Guthrie	69	8	11.59	5	7.25
Hart Lake	65	16	24.62	4	6.15
Helga	60	13	21.67	3	5.00
Hendrickson	36	10	27.78	3	8.33
Henrietta	79	23	32.86	3	3.80
Hubbard	78	19	24.36	7	8.97
Lake Alice	11	6	54.54	1	9.09
Lake Emma	34	5	14.71	3	8.82
Lake George	33	12	36.36	1	3.03
Lake Hattie	27	7	25.93	2	7.41
Lakeport	62	9	14.52	4	6.45
Mantrap	77	10	12.99	3	3.90
Nevis	91	22	24.18	2	2.20
Rockwood	35	7	20.00	3	8.57
Schoolcraft	18	4	22.22	..	...
Straight River	95	26	27.37	6	6.32
Steamboat River	2	...	....	1	50.00
Thorpe	14	1	7.14	..	...
Todd	60	24	40.00	4	6.67
White Oak	86	25	29.07	3	3.49
Total, county	1,358	341	25.11	74	5.45

* Data taken as of June 30, 1930.

MORTGAGE INDEBTEDNESS AND SPECIFIC LAND USE

Sixty-two per cent of total active mortgage debt on land in agricultural use involved land operated by owners or their lineal descendants. It involved 72,178 acres or 51 per cent of the total area in the county so operated. That is, over one-half of the farm area that was owner-operated was mortgaged. The mortgage debt on this area was 57 per cent of the equalized true and full value of land involved. This land had an average debt of $15.76 and a true and full value of $27.75 per acre.

The percentage of owner-operated land that was mortgaged varied (Table 81) by townships from 16 per cent in Clay Township to 68 per cent in Straight River. Ten townships had a larger percentage of their owner-operated land mortgaged than the average for the county. They were Straight River, Lake Alice, Mantrap, Thorpe, Helga, Nevis, White Oak, Lakeport, Fern, and Akeley. The high percentage of mortgaged owner-operated farms in these townships may be attributed to an active effort on the part of the owners to develop their land, perhaps by land clearing, as all of these townships are in the timber area. Hart Lake, Guthrie, and Farden were also relatively high, for the same reason. Hubbard, Henrietta, and Todd were low, perhaps because of the original prairie cover, especially in Hubbard and Todd, and hence a lesser need for funds for land development.

The average mortgage debt per acre for the county on this type of land was $15.76 (Table 82) and ranged from $5.05 in Clover Township to $26.61 in Hubbard Township. Ten Townships above the average were: Hubbard, $26.61; Todd, $23.03; Guthrie, $19.91; Nevis, $19.90; Straight River, $19.51; Henrietta, $19.35; Lakeport, $17.45; Helga, $16.22; Farden, $16.01, and Hendrickson, $15.55. Townships with an average debt per acre of less than $10 were: Clover, $5.05; Steamboat River, $6.05; Fern, $6.77; Clay, $7.89; Schoolcraft, $8.01; Arago, $8.57, and Lake Emma, $9.26.

The ratio of debt to valuation for the county as a whole for this type of land was 57. This ratio for all mortgaged land, regardless of use, for the county was 57. The range in ratios extended from 37 per cent in Fern to 109 per cent in Hendrickson. This extremely wide range can be explained only by a disproportionate valuation for tax assessment. Fern had a debt of $6.77 per acre and a valuation of $24.11. Hendrickson, on the other hand, had a debt of $15.55 per acre and an equalized valuation of $14.27. The valuation for Fern was very close to the average valuation in the county, whereas the valuation in Hendrickson was slightly over one-half the average in the

Table 81

Percentages of Areas, in Agricultural Uses, That Are Mortgaged

Township	Owner-operated	Tenant-operated	Vacant, operated	Meadow, pasture and waste	Abandoned land
Akeley	51.29	36.34	41.30	21.41	18.98
Arago	46.51	73.19	53.06	....	33.52
Badoura	48.95	31.16	50.55	61.54	38.46
Clay	16.35	....	....	....	14.97
Clover	39.08	....	31.22	....	50.87
Crow Wing Lake	45.18	61.64	53.80	....	65.46
Farden	48.63	11.42	27.64	....	62.96
Fern	52.93	....	27.02	....	64.65
Guthrie	47.27	89.98	59.14	....	....
Hart Lake	44.72	35.09	31.30	....	81.82
Helga	61.16	16.26	34.46	....	100.00
Hendrickson	49.33	77.78	45.77	5.35	28.57
Henrietta	36.53	52.27	36.51	....	37.30
Hubbard	34.28	58.45	48.92	3.86	26.09
Lake Alice	67.71	....	....	....	73.98
Lake Emma	41.44	28.81	30.25	....	35.74
Lake George	43.80	60.14	77.78	28.26	46.93
Lake Hattie	50.30	64.29	42.13	....	....
Lakeport	54.95	61.92	98.35	....	55.40
Mantrap	63.69	70.59	64.84	....	58.95
Nevis	60.41	71.22	72.61	....	59.10
Rockwood	44.27	85.89	40.17	....	7.11
Schoolcraft	36.78	....	31.24	....	39.08
Steamboat River District	47.97	....	....	....	....
Straight River	67.88	54.87	53.64	....	76.92
Thorpe	61.93	....	48.27	....	4.35
Todd	42.09	35.64	25.40	....	43.23
White Oak	56.52	51.59	37.45	....	44.71
Total, county	51.12	50.55	42.47	7.19	42.21

Summary of percentages in various uses that are mortgaged

Total agricultural	46.68
Timber and potential timber	17.58
Abandoned or residual timber land	14.56
Total timber land	14.67
Water power	3.43
Recreational	10.16

Table 82

Summary of Active Mortgage Indebtedness According to Land-Use Types

Type of land use	Mortgage debt	Average mortgage			Equalized value per acre	Loan valuation ratio	Per cent of type area mortgaged
		mortgaged area, acres	per acre	equalized value			
Owner-operated farms	$1,139,686.61	72,297.79	$15.76	$2,006,351.03	$27.75	56.80	51.20
Tenant-operated farms	272,044.77	14,962.29	18.18	502,872.61	33.61	54.10	50.56
Vacant, operated farms	324,397.16	21,810.17	14.87	522,624.28	23.96	62.07	42.47
Meadow, pasture, idle	6,059.26	916.15	6.61	14,469.72	15.79	41.88	7.19
Abandoned farm land	83,509.39	7,434.01	11.23	129,074.93	17.36	64.70	42.21
Timber, potential timber	16,869.41	2,083.26	8.10	33,098.09	15.89	50.97	17.58
Abandoned or residual timber	362,160.56	45,227.30	8.01	663,128.32	14.66	54.61	14.56
Water power	2,020.00	245.32	8.23	2,980.80	12.15	67.77	3.43
Recreational	25,439.72	1,220.64	20.84	64,086.62	52.50	39.70	10.16
Total agricultural	1,825,697.19	117,420.41	15.55	3,175,392.57	26.04	47.50	46.68
Total forest	379,029.97	47,310.56	8.01	696,226.41	14.72	54.44	14.67
Total water power	2,020.00	245.32	8.23	2,980.80	12.15	67.77	3.43
Total recreational	25,439.72	1,220.64	20.84	64,086.62	52.50	39.70	10.16
Total in county	$2,232,186.88	166,196.93	$13.43	$3,938,686.40	$23.70	56.67	27.85

county. The difference in debt may be due partly to differences in percentage of active loan value.

Of the total area of farm land operated by the owner, 9 per cent had been foreclosed (Table 83). The range by townships extended from 2 per cent in Henrietta to 22 in Schoolcraft. Townships with a large proportion of land that had been foreclosed, now owner-operated, were: Nevis, Badoura, Clay, Lake Hattie, and White Oak. Those with low percentages of foreclosure were: Henrietta, Rockwood, Guthrie, Lakeport, Hart Lake, Fern, and Todd. The ratio of debt to value was 45, which was somewhat lower than the ratio of active mortgages. This may be explained in general by the fact that active mortgages have been issued more recently, when values were on a higher level than the values on foreclosed mortgages that obviously had been issued at an earlier period. The range in debt to value ratios extended from 16 per cent in Schoolcraft to 118 in Crow Wing, which was a wider range than was found in the active. Only eight townships had a ratio that was higher than the average.

The ratio of total amount of debt foreclosed to amount of active debt for the county, on this type of land, was 12 per cent, and ranged from 2 per cent in Rockwood to 140 per cent in Clover, where a larger amount of mortgaged debt had been foreclosed than was active. Another township with an unusually high ratio of foreclosed to active debt was Clay, with 84 per cent. These unusual ratios are not explained by the ratios of debt to valuations, which were lower than the average for the county. They may be interpreted as examples of high mortality of mortgages issued on active farm land in these townships. The relatively small amounts involved either in active or foreclosed mortgages further indicate limited agricultural development.

Fourteen townships had a ratio of foreclosed to active mortgages of less than the average for the county. Three townships—Mantrap, Steamboat River, and Thorpe—showed no foreclosures. The average ratio of foreclosed area in this use to area under active mortgage for the county as a whole was 17 per cent. It ranged from 4 per cent in Henrietta to 100 per cent in Clay. Clover was likewise high, with 83 per cent. Eleven townships had area ratios of less than the average for the county. Of the northeast group of townships (Farden, Helga, Hart Lake, Guthrie, Lakeport, Fern, and Rockwood) with relatively greater agricultural development, Farden was higher than the average in amount and area and Helga was below the average in both area and amount. Of the more highly developed townships in the south of the county, only Henrietta, Todd, and Straight River were below

Table 83

A Summary of Foreclosed Mortgage Indebtedness According to Land-Use Types

Type of land use	Mortgage debt	Average mortgage			Equalized value per acre	Loan valuation ratio	Per cent of type area foreclosed	Ratio to actively mortgaged	
		mortgaged area, acres	per acre	equalized value				amount	area
Owner-operated farms	$140,551.58	12,157.04	$11.56	$ 311,630.37	$25.63	45.10	8.61	12.33	16.82
Tenant-operated farms	154,785.70	7,654.70	20.22	267,612.67	34.96	57.84	25.86	56.90	51.16
Vacant, operated farms.....	147,229.52	11,348.65	12.97	265,602.53	23.40	55.43	22.10	45.39	52.03
Meadow, pasture, idle.....	1,553.39	476.15	3.26	7,957.20	16.71	19.52	3.74	25.64	51.97
Abandoned farm land.....	44,486.86	5,508.53	8.08	97,094.22	17.63	45.82	31.27	53.27	74.10
Timber, potential timber.....	4,933.80	979.50	5.04	14,771.13	15.02	33.40	8.26	29.25	47.02
Abandoned or residual timber	172,763.96	27,115.24	6.37	387,663.88	14.30	44.57	8.73	47.05	59.79
Water power	.....	.....	....	.....	....	....	....	....	....
Recreational	5,060.12	448.09	11.29	11,821.99	26.38	42.80	3.73	19.90	36.71
Total agricultural.....	488,607.05	37,145.07	13.15	949,896.99	25.57	51.44	14.77	26.76	31.63
Total forest	177,697.76	28,094.74	6.32	402,435.01	14.32	44.16	8.69	46.88	59.38
Total water power.....	.....	.....	....	.....	....	....	....	....	....
Total recreational	5,060.12	448.09	11.29	11,821.99	26.38	42.80	3.73	19.90	36.71
Total in county.....	$671,364.93	65,687.90	$10.22	$1,364,153.99	$20.77	49.21	11.01	30.01	39.52

the average for the county for both amount and area, while Hubbard was slightly above the average in both.

The area involved in mortgages satisfied between October 1929 and June 1930 represented 3 per cent (Table 84) of the total area in this type of land use. The ratio of area involved in satisfied mortgages to area under active mortgage was 5. The range among the townships extended from 3 per cent in Mantrap to 51 in Steamboat River. This high ratio was due to the fact that only a few mortgages had been issued and the satisfaction of one constituted a relatively high percentage of the total. Six townships were below the average for the county. The ratio of amounts involved in satisfied mortgages to those in active mortgages was 4 and ranged from 0.13 per cent in Mantrap to 32 in Steamboat River. Eleven townships were above the average in this respect. The ratio of debt to value in this group of townships was lower than the ratio of active or foreclosed mortgages. The average mortgage debt was $11.83, which was about one-half of the debt on actively mortgaged land. The average valuation was $27.63, which was above that of either actively or foreclosed mortgaged land. The lower debt per acre and the higher valuation per acre suggest that the land included in this group was not typical of the land for the county as a whole. There was no close relationship between ratios of satisfied mortgages to active mortgages and general agricultural development.

Of the land that was operated by a resident tenant, 14,962 acres were under active mortgage, or 51 per cent of the total. The average mortgage debt was $18.18 per acre, compared with $15.76 for land operated by the owner. The valuation per acre was $33.61 for the tenant-operated land, compared with $27.75 for owner-operated land. The higher values under resident-tenant operation were due to the fact that this type of land use was not found in seven townships with relatively low values. The range in debt per acre extended from $5.62 in Badoura to $38.57 in Lakeport. This high value may partly account for a higher average acre debt. The ratio of debt to valuation was 54 and ranged from 32 in Straight River to 170 in Lakeport. This is an abnormal range, especially since two other townships had ratios of over 100. These were Lake George with 130 and Hart Lake with 118.

The percentage of total area, tenant-operated, that had been foreclosed was 26. The ratio of the amount foreclosed to amount in active mortgages was 57 per cent, while the ratio of foreclosed acres to acres under active mortgage was 51 per cent.

Table 84

A Summary of Satisfied Mortgage Indebtedness According to Land-Use Types*

Type of land use	Mortgage debt	Average mortgage			Equalized value per acre	Loan valuation ratio	Per cent of type area satisfied	Ratio to actively mortgaged	
		mortgaged area, acres	per acre	equalized value				amount	area
Owner-operated farms	$49,995.51	3,890.01	$12.85	$102,232.13	$26.28	48.90	2.76	4.39	5.38
Tenant-operated farms	14,712.43	1,080.92	13.61	40,328.43	37.31	36.48	0.65	5.40	7.22
Vacant, operated farms	17,155.07	1,488.35	11.53	30,329.49	20.38	56.56	2.90	5.29	6.83
Meadow, pasture, idle	.....	.....	....	.....	....	....	....	....	....
Abandoned farm land	970.07	278.48	3.48	5,789.54	20.79	16.76	1.58	1.16	3.75
Timber, potential timber	.....	.....	....	.....	....	....	....	....	....
Abandoned or residual timber	9,284.49	1,206.67	7.69	28,756.36	23.91	32.17	0.40	2.56	2.70
Water power	.....	.....	....	.....	....	....	....	....	....
Recreational	4,757.50	162.85	29.21	17,539.56	107.70	27.12	1.98	18.70	13.34
Total agricultural	82,833.08	6,737.76	12.29	178,679.59	26.52	46.36	2.68	4.54	5.74
Total forest	9,284.49	1,206.67	7.69	28,856.36	23.91	32.17	0.37	2.45	2.55
Total water power	.....	.....	....	.....	....	....	....	....	....
Total recreational	4,757.50	162.85	29.21	17,539.56	107.70	27.12	1.31	18.70	13.34
Total in county	$96,875.07	8,107.28	$11.95	$225,075.51	$27.76	43.04	1.36	4.34	4.88

* October 1929 to June 1930.

The tenant-operated land on which mortgages were satisfied from October 1929 to June 1930 was confined to six townships—Badoura, Guthrie, Helga, Hubbard, Todd, and White Oak. The ratios of amount and area involved in satisfaction to amount and area under active mortgage were 5 and 7 per cent, respectively. The ratio of debt to value was 36 per cent, which was somewhat below the corresponding ratio for owner-operated land. This would indicate relatively light encumbrance.

Of the 51,350 acres operated by nonresident tenants, 21,810 acres, or 42 per cent, were under active mortgage. The mortgage debt per acre was $14.87 and ranged from $5.28 in Rockwood to $19.87 in Lake George. The average valuation per acre was $23.96 and ranged from $15.65 in Badoura to $42.29 in Straight River. The average ratio of debt to valuation was 62 and ranged from 26 in Thorpe to 137 in Lake George. The average ratio was somewhat higher than the corresponding ratio for either owner- or resident-tenant–operated land. Twenty-two per cent of the total area of land operated by nonresident tenants had been foreclosed. The ratios of foreclosures to active mortgages were 45 and 52 per cent for amount and area, respectively. The ratio of debt to valuation was 55 per cent.

Mortgages were satisfied on 3 per cent of the total area in this class during the period studied. The ratios of satisfied to active mortgages were 5 and 7 for amounts and area involved, respectively. The ratio of debt to valuation was 57, with a range from 28 in Hart Lake to 172 in Helga.

Land in miscellaneous use such as meadow, pasture, and idle land, was grouped together. This represented land of which some use was made, but which use was more or less indifferent. The area involved was smaller than that operated by nonresident tenants. It constituted only a relatively small proportion of land in agricultural use. It was found in the five townships of Akeley, Badoura, Hendrickson, Hubbard, and Lake George. Seven per cent of the total area in this use was mortgaged. The average mortgage per acre was $6.61, and the valuation was $15.79. The ratio of loan to value was 42 per cent and ranged from 24 per cent in Lake George to 88 per cent in Hendrickson.

The area that had been foreclosed was 4 per cent of the total area in this use and was 52 per cent of the area under active mortgage. The ratio of amount foreclosed to active was 26 per cent. The ratio of debt to value was 20, with a range from 9 in Lake George to 48 in Badoura.

No mortgage debt on this class of land had been satisfied during the period studied.

MORTGAGE DEBT ON ABANDONED FARM LAND

Of land once dedicated to agriculture, 17,613 acres had been abandoned. Of this area, 7,434 acres, or 42 per cent, were mortgaged. Such land was found in all townships except Guthrie, Lake Hattie, and Steamboat River. The average debt per acre was $11.23, ranging from $1.31 in Hubbard to $16.21 in White Oak. The average valuation per acre was $17.36, with a range from $12.48 in Schoolcraft to $25.30 in Straight River. The average ratio of loan to value was 65 per cent and ranged from 7 in Hubbard to 109 in Hendrickson.

Thirty-one per cent of the total abandoned area in the county had been foreclosed. The ratios of foreclosed to actively mortgaged land as to amount and area involved were 53 and 74 per cent, respectively. Both of these ratios are high. The average loan per acre was $8.08, with a range from $0.53 in Clay to $17.50 in Arago. The average equalized value per acre was $17.63, with a range from $12.63 in Mantrap to $30.75 in Straight River. The ratio of loan to valuation was 46 for the county as a whole, with a range from $4 in Clay to $85 in Lake Alice. The low ratio in Clay was accounted for by a loan of $0.53 per acre on land with a valuation of $14.79.

Mortgage debt on abandoned land was satisfied in only four townships. This satisfaction involved only 278 acres, or 2 per cent, of the total abandoned area. The ratios of amount and area of satisfied to active mortgage indebtedness likewise were low, being 1 and 4 per cent, respectively. The average satisfied loan per acre was $3.48 on an average valuation of $20.79, or a ratio of 17 per cent. This loan to value ratio was much lower than the corresponding ratio for foreclosed and actively mortgaged land in other uses.

MORTGAGE DEBT ON TIMBER LAND

The 323,423 acres dedicated to timber use, or the residue of timber use, may be divided roughly into two classes. The first would include young and merchantable timber, and the other, residual or cut-over land. The former covers 11,853 acres and the latter 310,598 acres. Of the former, 2,083 acres, or 18 per cent, were under active mortgages amounting to $16,869. This area was limited to 13 townships, all but two of which were in what have been referred to as agricultural townships. The average mortgage per acre was $8.10 and ranged from $3.50 per acre in Rockwood Township to $80.00 in Henrietta. This latter extreme involved only 7 acres and hence is not significant. The next lower loan per acre was $24.96 in Hart Lake and was a more representative upper limit. The average equalized value per acre was $15.89, with a range from $8.17 in Mantrap to $56.41 in Henrietta, as the extreme,

and $24.35 in Farden as a more representative limit. The ratio of loan to valuation was 51, with a range from 21 in Guthrie to 542 in Hart Lake. This extremely high ratio was due to a loan of $24.96 per acre on an acre valuation of $4.60. Mantrap had a loan of $14.29 per acre, with an acre valuation of $8.17, or a ratio of 175. Henrietta had an average loan of $80.00, with an acre valuation of $56.41, or a ratio of 142.

Of the potential timber land, 8 per cent had been foreclosed. The ratios of amount and area involved of foreclosed to actively mortgaged land were 29 and 47 per cent, respectively. The average foreclosed loan per acre was $5.04 with a valuation of $15.02 and a ratio of 33. The foreclosed area in this class was confined to five townships. None of the mortgaged area in this class was redeemed during the period studied.

Of the 310,598 acres of residual or cut-over type, 45,227, or 15 per cent, were under active mortgage. The average loan per acre on this area was $8.01, with an average valuation of $14.66 and a ratio of loan to valuation of 55. The average loan per acre varied from $4.54 in Lake George to $13.42 in White Oak. The valuation per acre ranged from $11.98 in Crow Wing to $20.02 in Straight River. Foreclosure had claimed 9 per cent of the total area in residual land use. The ratios of amount and area of foreclosed to actively mortgaged cut-over land were 57 and 60 per cent, respectively. The average foreclosed loan per acre was $6.37 on an average valuation of $14.30, or a loan valuation ratio of 45. The loan per acre varied from $2.61 in White Oak to $15.63 in Hubbard. The valuation varied from $8.74 in Hart Lake to $21.34 in Straight River. Very little (0.4 per cent) of the land in this class was redeemed during the period studied. The ratio of amount of satisfied mortgaged to amount of active mortgage was 3 and the ratio of area satisfied to area under active mortgage was 3. The ratio of loan to value was 32, or the average relation between $7.63, an average loan per acre, and the average valuation of $23.91 per acre.

Land used for recreation purposes included areas occupied by commercial farm resorts, summer homes, summer cottages rented by individuals or companies, as well as non-commercial resorts such as clubs. There were 8,213 acres dedicated to this use in Hubbard County. Of this total area 1,221 acres, or 15 per cent, were mortgaged, 4 per cent had been foreclosed, and 2 per cent had been redeemed during the period from October 1929 to June 1930. On active mortgage debts, the average loan per acre was $20.84, with an equalized valuation of $52.50 and a loan valuation ratio of 40. The loan per acre varied from $5.69 in Mantrap to $153.85 in Todd. The valuation varied from $26.28 in Mantrap to $866.48 in Todd. The loan valuation ratio varied

from 18 in Todd to 120 in Thorpe. This type of land use was found in only 12 townships.

Recreation property was foreclosed in only seven townships. The ratios of foreclosed to actively mortgaged land were 20 and 37 for amount and area involved, respectively. The loan per acre varied from $2.22 in Badoura to $21.09 in Lake Emma. The valuation per acre ranged from $12.87 in Badoura to $105.99 in Todd. The loan valuation varied from $9.48 in Fern to $64.27 in Nevis.

Two per cent of the total area in recreation use had been redeemed during the period studied. This was confined to three townships. The average loan per acre was $29.21 on a valuation of $107.70, or a loan valuation ratio of 27. Tables 85, 86, and 87 summarize the percentages of active, foreclosed, and satisfied mortgages for the various land uses.

MORTGAGE DEBT OUTSIDE FARMS

There were 48,777 acres of land not in agricultural use that were mortgaged for $406,490, or an average of $8.33 per acre. The average true and full value per acre of this land was $15.65. The ratio of mortgage debt to full value was 53. Steamboat River, with 2,893 acres, had the largest area of this land, while the smallest area so encumbered was in Todd, with only 202 acres. The average acreage mortgaged per township was 1,741. Thirteen townships had more than the average, and 15 had less. The highest amounts in this class were found in the relatively undeveloped townships, while the lower amounts were found in the townships with more agricultural development. Lake Hattie Township had the largest amount of indebtedness on this type of land, $31,234, or $11.42 per acre. Clay had the smallest amount, $4,922, or $4.53 per acre. This low total amount and amount per acre apparently indicated either little need for loans or a low loan value.

The amount of loan per acre for the county on this type of land was $8.33 as against $13.43 for all mortgaged land and $15.55 on land bought for agricultural use. The amounts ranged from $4.53 in Clay to $13.44 in Straight River. As might be expected, the loans above average were in the more developed and more thickly settled townships, and the low average loans per acre were in the undeveloped townships.

The average value per acre of land mortgaged was $15.65 as against $23.70 for all mortgaged land and $27.04 for land in agriculture. The lowest average valuation was found in White Oak Township, with $13.17, and the highest valuation was in Todd, $50.41. This high valuation in Todd was due to the inclusion of loans on recreational property where the value per acre is rather high. Seventeen townships were below the average and eleven above the average acre valuation.

Table 85

Active Mortgage Indebtedness and Land Use

Type of land use	Per cent of total area	Average loan per acre	Average valuation per acre	Loan valuation ratio
Owner-operated	51.20	$15.76	$25.75	56.80
Resident-tenant-operated	50.56	18.18	33.61	54.10
Nonresident-tenant-operated	42.47	14.87	23.96	62.07
Meadow, pasture, and waste	7.19	6.61	15.79	41.88
Abandoned farm land	42.21	11.23	17.36	64.70
Total agricultural	46.68	15.55	26.04	47.50
Timber	17.58	8.10	15.89	50.97
Cut-over	14.56	8.01	14.66	54.61
Total forest	14.67	8.01	14.72	54.44
Water power	3.43	8.23	12.15	67.77
Recreational	10.16	20.84	52.50	39.70
Total for county	27.85	$13.43	$23.70	56.67

Table 86

Foreclosed Mortgage Indebtedness and Land Use

Type of land use	Per cent of total area	Average loan per acre	Average valuation per acre	Loan valuation ratio	Ratio to actively mortgaged	
					amount	area
Owner-operated	8.61	$11.56	$25.63	45.10	12.33	16.82
Resident-tenant-operated	25.86	20.22	34.96	57.84	56.90	51.16
Nonresident-tenant-operated	22.10	12.97	23.40	55.43	45.39	52.03
Meadow, pasture, and waste	3.74	3.26	16.71	19.52	25.64	51.97
Abandoned farm land	31.27	8.08	17.63	45.82	53.27	74.10
Total agricultural	14.77	13.15	25.57	51.44	26.76	31.63
Timber	8.26	5.04	15.02	33.40	29.25	47.02
Cut-over	8.73	6.37	14.30	44.57	47.05	59.79
Total forest	18.59	6.32	14.32	44.16	46.88	59.38
Water power	....	....	....	....	....	....
Recreational	3.73	11.29	26.38	42.80	19.90	36.71
Total for county	11.01	$10.22	$20.77	49.21	30.01	39.52

Table 87

Mortgages Satisfied from October 1929 to June 1930

Type of land use	Per cent of total area	Average loan per acre	Average valuation per acre	Loan valuation ratio	Ratio to actively mortgaged	
					amount	area
Owner-operated	2.76	$12.85	$26.28	48.90	4.39	5.38
Resident-tenant-operated	3.65	13.61	37.31	36.48	5.40	7.20
Nonresident-tenant-operated	2.90	11.53	20.38	56.56	5.29	6.83
Meadow, pasture, and waste	....	....	....	....	....	....
Abandoned farm land	1.58	3.48	20.79	16.76	1.16	3.75
Total agricultural	2.68	12.29	26.52	46.36	4.54	5.74
Cut-over	0.40	7.69	23.91	32.17	2.56	2.70
Total forest	0.37	7.69	23.91	32.17	2.45	2.55
Water power	....	....	....	....	....	....
Recreational	1.98	29.21	107.70	27.12	18.70	13.34
Total for county	1.36	$11.95	$27.76	43.04	4.34	4.88

The ratio of loan to equalized value for mortgaged land in the county outside of farms was 53 as against 57 for all mortgaged land and 57 for mortgaged land in farms. The ratios ranged more widely from 30 in Clay Township to 82 in Crow Wing. Thirteen townships were below the average and fifteen above. There was no general grouping of townships either as to location or degree of development with regard to the ratio, as some well-developed townships were above the average and some below. The same applied to the undeveloped townships.

Two hundred and twenty-two mortgages on land outside of farms, involving $183,213 on 28,611 acres, were foreclosed. The average debt per acre for the county was $6.40 and ranged from $2.79 in White Oak Township to $15.63 in Hubbard. The average valuation for this land was $14.50 and ranged from $9.97 in Hart Lake to $18.95 in Helga. The loan valuation ratio for the county was 44 and ranged from 16 to 90. It is seen that the average debt per acre was lower than the corresponding figure per acre under active mortgage. Valuation was lower, but not as much lower as debt. The loan valuation ratio on foreclosed land was considerably lower than the loan valuation ratio on actively mortgaged land.

Table 88 shows the ratios of the number of foreclosed and satisfied

Table 88

Ratios of Number of Foreclosed and Satisfied Mortgages to the Number of Active Mortgages on Land Outside of Farms

Township	Active mortgages	Foreclosed mortgages	Ratio of foreclosed to active	Satisfied mortgages	Ratio of satisfied to active
Akeley	9	1	11.11	2	22.22
Arago	23	66	13.08	..	...
Badoura	22	12	54.54	..	...
Clay	13	12	92.31	..	...
Clover	17	3	17.65	..	...
Crow Wing	17	12	70.59	..	...
Farden	14	9	64.28	..	...
Fern	9	5	55.55	..	...
Guthrie	21	6	28.57	..	...
Hart Lake	14	5	35.71	..	...
Helga	10	9	90.00	1	10.00
Hendrickson	21	10	47.62	..	...
Henrietta	10	2	20.00	4	40.00
Hubbard	11	1	9.09	4	36.36
Lake Alice	20	15	75.00	..	...
Lake Emma	18	11	61.11	2	11.11
Lake George	30	15	50.00	2	6.67
Lake Hattie	16	18	112.50	1	6.25
Lakeport	26	12	46.15	4	15.38
Mantrap	20	1	5.00	1	5.00
Nevis	18	8	44.44	..	...
Rockwood	19	15	78.94	1	5.26
Schoolcraft	21	11	52.38	..	...
Straight River	13	7	53.85	..	...
Steamboat River	27	6	22.22	..	...
Thorpe	12	5	41.67	..	...
Todd	5	..	....	..	...
White Oak	21	5	23.81	..	...
Total, county	477	222	46.54	21	4.40

mortgages to the number of active mortgages on land outside of farms. It is evident that the ratio of the number of foreclosed to active mortgages was very high for this type of land use, being 47. It ranged from 5 per cent in Mantrap to 112 per cent in Lake Hattie where 18 mortgages had been foreclosed and there were only 16 now active.

Only 21 mortgages were satisfied on this type of land during the short period studied. The number ranged from none in 18 townships to four each in Henrietta, Hubbard, and Lakeport. The ratio of satisfied mortgages to number of active mortgages was 4.40 for the county and ranged from 5 per cent in Mantrap to 40 per cent in Henrietta.

Comparing the ratios of the numbers of foreclosed and satisfied mortgages to the number of active mortgages on land in agricultural use, and use outside of farms, it is evident that the mortality is relatively greater in general in mortgages on land outside of farm use. The ratio of foreclosed to active mortgages on farm land was 25 as compared to a corresponding ratio of 47 on land outside of farms. The ratio of satisfied mortgages to active mortgages was higher on farm land than on land outside of farms, being 5 per cent as compared with 4 per cent, respectively.

SUMMARY OF MORTGAGE INDEBTEDNESS

The relationship of mortgage indebtedness and intent of ownership as indicated by land use is summarized in Table 89. This table presents data for the county as a whole on the amount of mortgage indebtedness, acreage involved, average loan per acre, total equalized true and full valuation, average equalized valuation per acre, ratio of loan to valuation, per cent of type area that was mortgaged, and the ratio of amount and area of foreclosed and satisfied indebtedness to amount and area under active mortgage indebtedness for the important subclasses of land use and also a total for each of the major classes of land use. The data on satisfied mortgages are not comparable to data on active or foreclosed mortgages as the data cover a period of only eight months. They have some value in comparing that condition in the various townships and among various uses.

Of the area of the entire county, 28 per cent was mortgaged for $2,232,187 on a valuation of $3,938,686. The average loan per acre was $13.43 and the average valuation $24.00, or a loan valuation ratio of 57.

Land in agricultural use ranked highest in per cent of area under active mortgage, with 47 per cent; forest land second, with 15 per cent; recreational third, with 10 per cent, and water power last, with 3 per cent.

Table 89

Summary of Mortgage Indebtedness in Hubbard County

	Akeley	Arago	Badoura	Clay	Clover	Crow Wing	Farden	Fern	Guthrie
ALL LAND IN HUBBARD COUNTY									
G. L. O.* land area, acres	21,841.74	20,137.03	22,818.80	21,927.69	21,874.31	19,462.38	21,605.13	22,342.03	22,589.63
Area mortgaged, acres	6,141.89	5,736.87	6,714.78	1,922.66	3,826.55	6,231.51	6,600.74	5,548.32	7,752.81
Per cent of G. L. O. area mortgaged	28.12	28.49	29.43	8.77	17.49	32.02	30.55	24.83	34.32
Equalized value of area mortgaged	$150,959.35	$115,709.99	$107,785.00	$30,731.58	$58,435.20	$120,658.95	$135,543.98	$119,245.42	$169,053.56
Average value per acre	$24.58	$20.17	$16.05	$15.98	$15.27	$19.36	$20.53	$21.49	$21.81
Amount of mortgage loan	$74,468.37	$49,516.24	$61,096.26	$13,269.80	$22,600.97	$76,410.06	$84,714.09	$43,649.04	$124,088.10
Average mortgage per acre	$12.12	$8.63	$9.10	$6.90	$5.91	$12.26	$12.83	$7.87	$16.01
Loan-valuation ratio	49.33	42.79	56.68	43.18	38.68	63.33	62.50	36.60	73.40
Number of mortgages	87	65	62	24	32	56	74	50	90
Average amount of mortgage	$855.96	$761.79	$985.42	$552.91	$706.28	$1,364.47	$1,144.79	$872.98	$1,378.76
FARM LAND									
Total area, acres	10,740.69	7,471.67	15,471.03	3,379.82	4,509.01	8,604.55	11,329.84	8,486.44	10,900.84
Mortgaged area, acres	5,245.61	3,383.42	4,280.02	835.56	1,090.83	4,184.30	5,276.92	3,962.49	5,578.31
Per cent of farm area mortgaged	48.84	45.28	27.66	24.72	24.19	48.63	46.58	18.69	51.17
Equalized value of area mortgaged	$133,540.30	$70,720.42	$74,778.75	$14,334.87	$18,988.80	$94,305.60	$114,287.03	$92,879.83	$131,119.34
Average value per acre	$25.46	$20.90	$17.47	$17.16	$17.41	$22.54	$21.66	$23.44	$23.51
Amount of mortgage loan	$68,430.00	$29,991.38	$44,567.68	$8,347.93	$6,106.07	$54,852.21	$75,709.64	$35,713.48	$101,659.09
Average mortgage per acre	$13.05	$8.86	$10.41	$9.99	$5.60	$13.11	$14.35	$9.01	$18.22
Loan-valuation ratio	51.24	42.41	59.60	58.24	32.16	58.16	66.25	38.45	77.53
Number of mortgages	78	42	40	11	15	39	60	41	69
Average amount of mortgage	$877.30	$714.80	$1,114.19	$758.90	$407.07	$1,406.47	$1,261.83	$871.06	$1,473.32
Debt, per cent of total debt	91.89	60.57	72.95	62.91	27.02	71.79	89.37	81.74	81.92
LAND OUTSIDE OF FARMS (Exclusive of platted area)									
Total area, acres	10,643.82	12,665.36	7,347.77	18,547.87	17,365.30	10,857.83	10,275.29	13,855.59	11,653.79
Mortgaged area, acres	896.28	2,353.45	2,434.76	1,087.10	2,735.72	2,047.21	1,323.82	1,585.83	2,174.50
Per cent of area mortgaged	8.42	18.58	33.14	5.86	15.75	18.85	12.88	11.45	18.66
Equalized value of area mortgaged	$17,419.05	$44,989.57	$33,006.25	$16,396.71	$39,446.40	$26,353.35	$21,256.95	$26,365.59	$37,934.22
Average value per acre	$19.43	$19.12	$13.56	$15.08	$14.42	$12.87	$16.06	$15.63	$17.45
Amount of mortgage loan	$6,038.37	$19,524.86	$16,528.58	$4,921.87	$16,494.90	$21,557.85	$9,004.45	$7,935.56	$22,429.01
Average mortgage per acre	$6.74	$8.30	$6.79	$4.53	$6.03	$10.53	$6.80	$5.00	$10.31
Loan-valuation ratio	34.67	43.40	50.08	30.02	41.82	81.80	42.36	30.10	59.13
Number of mortgages	9	23	22	13	17	17	14	9	21
Average amount of mortgage	$670.93	$848.91	$751.30	$378.61	$970.29	$1,268.11	$643.18	$881.73	$1,068.05
Debt, per cent of total debt	8.11	39.43	27.05	37.09	72.98	28.21	10.63	18.26	18.08

* General Land Office

Table 89—Continued

Summary of Mortgage Indebtedness in Hubbard County

	Hart Lake	Helga	Hendrickson	Henrietta	Hubbard	Lake Alice	Lake Emma	Lake George	Lake Hattie
ALL LAND IN HUBBARD COUNTY									
G. L. O. land area, acres	21,635.33	21,532.70	22,904.97	21,008.31	21,580.68	21,971.10	17,672.63	21,652.68	21,241.29
Area mortgaged, acres	7,317.10	6,990.75	4,277.05	9,104.46	8,668.93	2,493.31	3,449.26	5,489.53	5,354.48
Per cent of G. L. O. area mortgaged	33.82	32.47	18.67	43.34	40.17	11.35	19.52	25.35	25.21
Equalized value of area mortgaged	$128,320.98	$154,285.89	$60,502.12	$344,067.49	$344,565.83	$41,022.84	$68,910.00	$79,497.00	$91,810.68
Average value per acre	$17.54	$22.07	$14.15	$37.79	$39.75	$16.45	$19.98	$14.48	$17.15
Amount of mortgage loan	$91,695.70	$107,020.14	$54,067.05	$150,854.74	$198,098.27	$20,876.82	$32,889.60	$41,119.65	$61,670.56
Average mortgage per acre	$12.53	$15.31	$12.64	$16.57	$22.85	$8.37	$9.54	$7.49	$11.52
Loan-valuation ratio	71.46	69.36	89.36	43.84	57.49	50.89	47.73	51.72	67.17
Number of mortgages	79	70	57	89	89	31	52	63	43
Average amount of mortgage	$1,160.71	$1,528.86	$948.54	$1,695.00	$2,225.82	$673.45	$632.49	$652.69	$1,434.20
FARM LAND									
Total area, acres	12,665.22	11,571.97	5,183.39	16,107.74	18,078.10	1,845.64	4,919.09	4,744.94	5,526.98
Mortgaged area, acres	5,180.35	5,919.77	2,463.72	8,239.66	7,728.65	713.75	1,846.11	2,449.92	2,618.55
Per cent of farm area mortgaged	40.90	51.16	47.53	51.15	42.75	38.67	37.53	51.63	47.38
Equalized value of area mortgaged	$99,605.40	$134,313.63	$35,168.88	$323,396.40	$327,165.49	$16,111.26	$38,817.00	$34,841.70	$53,421.12
Average value per acre	$19.23	$22.69	$14.27	$39.25	$42.33	$22.57	$21.03	$14.22	$20.40
Amount of mortgage loan	$76,884.97	$94,128.69	$35,550.07	$140,298.16	$190,619.50	$7,598.80	$18,935.26	$27,763.82	$30,436.77
Average mortgage per acre	$14.84	$15.90	$14.43	$17.03	$24.66	$10.65	$10.26	$11.33	$11.62
Loan-valuation ratio	77.19	70.08	101.08	43.38	58.26	47.16	48.78	79.69	56.98
Number of mortgages	65	60	36	79	78	11	34	33	27
Average amount of mortgage	$1,182.85	$1,568.81	$987.50	$1,775.93	$2,443.85	$690.80	$556.92	$841.33	$1,127.29
Debt, per cent of total debt	83.85	87.95	65.75	93.00	96.22	36.40	57.57	67.52	49.35
LAND OUTSIDE OF FARMS (Exclusive of platted area)									
Total area, acres	8,970.11	9,926.73	17,721.58	4,876.41	3,475.50	20,125.46	12,753.54	16,907.74	15,754.31
Mortgaged area, acres	2,136.75	1,070.98	1,813.33	864.80	940.28	1,779.56	1,603.15	3,039.61	2,735.93
Per cent of area mortgaged	23.82	10.79	10.23	17.73	8.19	8.84	12.57	17.98	17.37
Equalized value of area mortgaged	$28,715.58	$19,972.26	$25,333.24	$20,671.09	$17,400.34	$24,911.58	$30,093.00	$44,655.30	$38,389.56
Average value per acre	$13.44	$18.65	$13.97	$23.90	$18.51	$14.00	$18.77	$14.69	14.03
Amount of mortgage loan	$14,810.73	$12,891.45	$18,516.98	$10,556.58	$7,478.77	$13,278.02	$13,954.34	$13,355.83	31,233.79
Average mortgage per acre	$6.93	$12.04	$10.21	$12.21	$7.95	$7.46	$8.70	$4.39	$11.42
Loan-valuation ratio	51.58	64.55	73.09	51.07	42.98	53.30	46.37	29.91	81.36
Number of mortgages	14	10	21	10	11	20	18	30	16
Average amount of mortgage	$1,057.91	$1,289.15	$881.76	$1,055.66	$679.89	$663.90	$775.24	$445.19	$1,951.11
Debt, per cent of total debt	16.15	12.05	34.25	7.00	3.78	63.60	42.43	32.48	50.65

Table 89—Continued

Summary of Mortgage Indebtedness in Hubbard County

	Lakeport	Mantrap	Nevis	Rockwood	School-craft	Steamboat River District	Straight River	Thorpe	Todd	White Oak	County total
ALL LAND IN HUBBARD COUNTY											
G. L. O. land area, acres	19,472.60	20,028.66	18,569.92	21,257.06	21,887.05	22,392.72	22,495.40	22,224.35	20,720.69	22,011.36	596,858.24
Area mortgaged, acres.....	7,847.28	7,396.96	7,430.14	4,463.92	3,760.35	3,050.05	11,700.36	2,172.91	6,126.14	8,627.82	166,196.93
Per cent of G. L. O. area mortgaged	40.30	36.93	40.01	21.00	17.18	13.62	52.01	9.78	29.55	39.20	27.85
Equalized value of area mortgaged	$133,516.72	$132,373.63	$183,844.08	$73,765.64	$53,455.36	$41,727.96	$481,030.76	$43,787.25	$275,882.82	$198,196.32	$3,938,686.40
Average value per acre....	$17.01	$17.90	$24.74	$16.52	$14.22	$13.68	$41.11	$20.15	$45.03	$22.97	$23.70
Amount of mortgage loan..	$114,966.99	$100,193.47	$133,344.76	$47,142.67	$29,663.62	$22,094.40	$210,316.87	$18,837.92	$131,701.95	$115,318.77	$2,232,186.88
Average mortgage per acre	$14.65	$13.55	$17.95	$10.56	$7.89	$7.24	$18.02	$8.67	$21.50	$13.37	$13.43
Loan-valuation ratio.....	86.11	75.69	72.53	63.91	55.49	52.95	43.83	43.02	47.74	58.18	56.67
Number of mortgages.....	88	97	109	54	39	29	108	26	65	107	1,835
Average amount of mortgage	$1,306.44	$1,032.92	$1,223.35	$873.01	$760.61	$761.88	$1,952.00	$724.54	$2,026.18	$1,077.75	$1,216.45
FARM LAND											
Total area, acres.....	8,436.59	9,307.47	9,730.39	6,993.98	3,581.90	423.73	16,876.96	3,108.12	16,488.26	15,076.47	251,560.83
Mortgaged area, acres.....	5,026.70	5,775.09	6,106.74	2,941.00	1,233.00	156.96	10,496.21	1,316.50	5,923.64	7,446.63	117,420.41
Per cent of farm area mortgaged	59.58	62.05	62.76	42.05	34.42	37.04	62.19	42.36	35.20	49.39	46.64
Equalized value of area mortgaged	$91,351.52	$108,333.61	$155,694.96	$51,546.68	$19,822.08	$2,407.26	$457,861.34	$32,262.30	$265,675.68	$182,641.32	$3,175,392.57
Average value per acre....	$18.17	$18.76	$25.50	$17.53	$16.08	$15.34	$43.62	$24.51	$44.58	$24.53	$27.04
Amount of mortgage loan....	$91,184.56	$85,281.60	$116,386.77	$35,768.24	$12,200.79	$950.00	$194,630.43	$12,449.98	$124,383.95	$99,867.35	$1,820,697.19
Average mortgage per acre	$18.14	$14.77	$19.06	$12.16	$9.90	$6.05	$18.54	$9.46	$21.43	$13.41	15.52
Loan-valuation ratio	99.82	78.72	74.75	69.36	61.55	39.46	42.51	38.59	48.07	54.68	57.46
Number of mortgages.....	62	77	91	35	18	2	95	14	60	86	1,358
Average amount of mortgage	$1,470.72	$1,107.55	$1,278.98	$1,021.95	$677.82	$475.00	$2,048.74	$889.28	$2,073.07	$1,161.25	$1,340.72
Debt, per cent of total debt	79.31	85.12	87.28	75.87	41.13	4.30	92.32	66.09	94.44	86.60	81.57
LAND OUTSIDE OF FARMS (Exclusive of platted area)											
Total area, acres.....	10,980.34	10,721.19	8,580.15	14,263.08	18,305.15	21,968.99	5,609.44	19,116.23	3,381.61	6,934.89	343,545.07
Mortgaged area, acres.....	2,820.58	1,621.87	1,323.40	1,522.92	2,527.35	2,893.09	1,204.15	856.41	322.50	1,181.19	48,896.52
Per cent of area mortgaged	25.69	15.13	15.42	10.68	13.81	13.17	21.47	4.48	9.54	17.03	14.23
Equalized value of area mortgaged	$42,165.20	$24,040.02	$28,149.12	$22,218.96	$33,633.28	$39,320.70	$23,169.42	$11,524.95	$17,137.14	$15,555.00	$770,223.83
Average value per acre....	$14.95	$14.82	$21.27	$14.59	$13.31	$13.59	$19.24	$13.46	$53.14	$13.17	$15.75
Amount of mortgage loan..	$23,782.43	$14,911.87	$16,957.99	$11,374.43	$17,462.83	$21,144.40	$16,186.44	$6,387.94	$7,318.00	$15,451.42	411,489.69
Average mortgage per acre.	$8.43	$9.19	$12.81	$7.47	$6.91	$7.31	$13.44	$7.46	$22.69	$13.08	$8.42
Loan-valuation ratio	56.40	62.03	60.24	51.19	51.92	53.77	69.86	55.43	42.70	99.33	53.42
Number of mortgages.....	26	20	18	19	21	27	13	12	5	21	477
Average amount of mortgage	$914.71	$745.59	$942.11	$598.65	$831.56	$783.13	$1,245.11	$532.33	$463.60	$735.76	852.18
Debt, per cent of total debt	20.69	14.88	12.72	24.13	58.87	95.70	7.68	33.91	5.56	13.40	18.43

Of the subclasses in agricultural use, owner-operated farms had 51 per cent of their total area under active mortgage; resident-tenant, 51 per cent; nonresident-tenant, 42 per cent; abandoned land, 42 per cent, and miscellaneous farm use, including pasture, meadow, and waste land, 7 per cent. This is logical in view of the relative need for capital in operating the land in question.

The loan valuation ratio was highest on abandoned land, with 65; that is, 65 per cent of the equalized valuation of abandoned land was covered by active mortgage indebtedness. This ratio is based on an average loan of $13.43 per acre and an average valuation of $23.70 per acre. Nonresident-operated land was next, with 62 per cent; owner-operated land next, with 57 per cent; tenant-operated land next, with 54, and miscellaneous farm land last, with 42 per cent.

Resident-tenant–operated farms were assessed at a higher valuation and carried larger loans per acre than did owner-operated farms. This could be due to a larger proportion of the loan value of rented farms being borrowed, so that the actual loan per acre was larger. The higher valuation of resident-tenant–operated land could scarcely be due to relatively higher quality land, or to the fact that rented land had more valuable improvements. Both of these conditions might have been true in some cases but scarcely in general. It might have been due to slight bias in assessment in favor of owner-operated land. Higher valuation on rented land appeared in nine townships and lower in twelve. Seven townships had no mortgaged rented farms.

Land in forest use or residual forest land was mortgaged to the extent of 15 per cent of its area. Land with young timber of some size and merchantable timber had 18 per cent of its area mortgaged. The loan valuation ratio of total timber or forest land, including cut-over land, was 54 and represented the relation between an average loan per acre of $8.01 and an average valuation of $14.72. Neither the average loan per acre nor the average valuation per acre seem to be representative of the relative values of timber land (young and merchantable) and cut-over land. The average loans per acre were $8.10 and $8.01, respectively, for timber and cut-over land, while the valuations per acre were $15.89 and $14.66.

Only 10 per cent of the area devoted to recreational use was under active mortgage. The loan per acre was the highest of any class of land use, $20.84, while the average full value was also highest, $52.50, and the loan valuation ratio was the lowest, 40. This condition is logical as the value per acre is highest due to relatively extensive improvements per acre. The low percentage of area mortgaged was also to be expected, since by far the largest percentage of the total area (53)

was used for summer homes, and consequently a place to spend rather than to make money.

Land intended for use as storage space for water power was small in area and confined mainly to one township. Only 3 per cent of the area in that use was mortgaged, and none had been foreclosed. The loan per acre was $8.23, and the average valuation per acre was $12.15.

The area involved in foreclosed mortgages was 65,687 acres, or 11 per cent of the total area of the county. The average foreclosed loan per acre was $10.22, with the average valuation of $20.77 per acre. Both of these values were lower than corresponding values for actively mortgaged land, because most of the active mortgages were issued from 1920 to 1928 when land values were relatively high and when larger and more optimistic loans were allowed. The foreclosures include mortgages issued at an earlier date, when values, and hence loans, were on a lower level. The average loan valuation ratio was 49, which also was lower than the corresponding ratio for active mortgages. It indicates that mortgages in effect represented a higher proportion of full valuation than did foreclosed mortgages.

Fifteen per cent of the total area in agricultural use had been foreclosed. Miscellaneous farm use had the lowest percentage of its area foreclosed, 4 per cent. Its loan valuation ratio was likewise lower than any of the subclasses of farm land. Owner-operated farm land was next higher, with 9 per cent of its area foreclosed. Its loan valuation ratio was 45, which was considerably lower than the corresponding ratio for actively mortgaged owner-operated land, 57. Leased land operated by a nonresident tenant had the next higher percentage of its area foreclosed, 22 per cent. Tenant-operated land was next, with 26 per cent, and abandoned land was last and highest in percentage of area foreclosed, with 31 per cent. The relatively high percentage of foreclosed land in the rented, leased, and abandoned classes indicated a tendency for foreclosed land to be associated with tenancy.

As stated above, loans per acre were highest on resident-tenant–operated land, both in actively mortgaged and foreclosed land. Leased land, i.e., nonresident-tenant–operated land, was next, owner-operated next, abandoned next, and finally the miscellaneous land in farm uses.

Of the land in timber use and cut-over land, only 9 per cent had been foreclosed. This had a loan valuation ratio of 44, representing the relation between an average loan of $6.32 per acre and an average valuation of $14.32. Restocking timber land was foreclosed to 8 per cent of its total area, while 9 per cent of the cut-over land area was foreclosed.

Only 4 per cent of the area dedicated to recreational use had been foreclosed. The loan valuation ratio for this type of land use was 43.

The ratio of amount and area involved in foreclosed mortgages to amounts and acreage involved in active mortgages was calculated for the county as a whole and for the major land uses. While this ratio is not as significant as a ratio of foreclosed mortgages to total mortgages issued, it is useful in making possible some comparison of mortgage mortality among the various land uses.

The ratios of acreage and amount involved in foreclosed mortgages for the county as a whole to corresponding figures under active mortgages were 40 and 30, respectively. For all agricultural land, ratios of acreage and amount of foreclosures to active mortgages were 32 and 27 per cent, respectively. Within the general agricultural use class, the highest ratio of foreclosed acreage to actively mortgaged was 74, in the case of abandoned land. Leased or nonresident-tenant–operated land and miscellaneous were next highest, with 52 per cent each; resident-tenant–operated land, with 51 per cent, next, and owner-operated land last, with 17 per cent. The ratios of amounts involved in foreclosed to active mortgages were: resident-tenant–operated land, 57 per cent; abandoned land, 53 per cent; leased land, 45 per cent; miscellaneous farm land, 26 per cent, and resident-owner–operated, 12 per cent. Insofar as foreclosure indicates inability to repay the loan with interest and hence unprofitable use under given economic conditions, these ratios support the thesis that, in general, foreclosures, failures, and abandonment of agricultural land are the result of a faulty land utilization policy, that land utilization is not a personal or local problem but rather of statewide and national scope.

The ratios of foreclosed areas and amounts to areas and amounts involved in active mortgages for land in forest use were much higher, being 59 and 47 respectively. Cut-over ratios were 60 and 47 per cent, respectively, for area and amounts.

These ratios for land in recreational use were 37 for area and 20 for amount involved.

The area on which mortgage indebtedness had been satisfied in the eight months from October 1929 to June 1930 was about one per cent of the total area of the county. During the same period, mortgage debt involving land in agricultural use was satisfied on about three per cent of the total area in this use. Land operated by resident tenants satisfied debt on land to the extent of about four per cent of the total area in similar use. Leased land or that operated by nonresident tenants satisfied debt involving three per cent of the total area in that use. Owner-operated land paid the mortgage on about three per cent of all the land in that use. Abandoned land cleared the smallest percentage of land in that use from mortgage, or only about two per cent. From

this, it appears that landlords were better able to meet obligations at that time than owners operating their own land.

The ratios of area and amount involved in satisfied mortgages to corresponding figures for active mortgages for all land uses in the county were 5 and 4 per cent, respectively. Land in agricultural use of all types indicated corresponding ratios of 6 and 5 for area and amounts, respectively. Corresponding ratios for timber lands were approximately three for both area and amount, and those for recreational land use were practically the same.

Active mortgage indebtedness in percentage is summarized in Table 90. It appears that 28 per cent of the total land area of the county outside of platted villages carried an active mortgage. Sixteen townships had a larger percentage of their area mortgaged than the average for the county. The range extended from Clay with 9 per cent to Straight River with 52. A larger proportion of total area was mortgaged in the townships with more agricultural development.

Fifty-seven per cent of the total true and full equalized valuation of the rural land of the county was mortgaged. Sixteen townships were above the average in percentage of valuation mortgaged, with a range from 37 in Fern to 89 per cent in Hendrickson.

The average loan per acre for all land mortgaged was $13.43, and the average valuation was $23.70 (Table 89). The range in per-acre loans extended from $5.91 in Clover to $22.85 in Hubbard. The valuation per acre ranged from $14.15 in Hendrickson to $39.75 in Hubbard.

There were 1,835 active mortgages for the county as a whole, or an average of 65 per township. The number per township varied from 26 in Thorpe to 108 in Straight River. Fourteen townships had less than the average number of mortgages and 14 had more than the average. The larger number of mortgages was associated with agricultural development.

The average size of mortgage for the county was $1,216, with a range from $552 in Clay Township to $2,226 in Hubbard Township. Ten townships had mortgages larger than the county average. Size of mortgage likewise seemed to be associated with agricultural development.

Of the total area in farm use in the county, 47 per cent was actively mortgaged. This percentage varied among the townships from 19 in Fern to 63 per cent in Nevis.

The loan valuation ratio on land in agricultural use for the county as a whole was 57. For the various townships this ratio ranged from 32 in Clover to 101 in Hendrickson. The average loan per acre of

farm land was $15.52 and ranged from $5.60 in Clover Township to $24.66 in Hubbard. The average valuation per acre in farm use was $27.04 and ranged from $14.22 in Lake George to $44.58 in Todd.

There were 1,358 mortgages on land in farm use, or an average of 48 per township. The range extended from 2 in Steamboat River to 91 in Nevis. The average amount per farm mortgage was $1,341 and ranged from $475 in Steamboat River to $2,444 in Hubbard. Both number and average amount of mortgage seemed to be associated with agricultural development.

The farm mortgage debt was 82 per cent of the total mortgage debt in the county. For the various townships, it varied from 27 per cent in Clover to 96 per cent in Hubbard. The percentage farm debt of total mortgage debt was directly associated with agricultural development.

Of the total land that was not in farm use, 14 per cent was mortgaged as compared with 47 per cent for land in farm use. This percentage ranged from 6 in Clay to 33 in Badoura.

The average loan valuation ratio on land not in farm use was 53, with a range from 30 per cent in Lake George to 99 per cent in White Oak. This did not represent as wide a range as the corresponding range for land in farm use. The average loan per acre on land outside of farms was $8.42 as compared with $15.52 for farm land. The range extended from $4.53 in Clay to $22.69 in Todd. The valuation per acre for the county was $15.75, with a range from $12.87 in Crow Wing to $53.44 in Todd. The next lower valuation of $23.90 in Henrietta was a more nearly representative upper limit.

The total number of mortgages on land outside of farms was 477, or an average of 17 per township. The number by townships varied from 5 in Todd to 27 in Steamboat River. Numbers of mortgages outside of farms varied inversely as the agricultural development and directly with proportion on idle or undeveloped land.

The average amount of mortgage on land outside of farm was $852 and varied from an average of $379 in Clay to $1,245 in Straight River.

Table 90 presents a summary of mortgage indebtedness on a percentage basis, by townships, for unplatted land, farm land and unplatted land outside villages but within corporate limits.

Table 90

Summary of Mortgage Indebtedness

Township	All unplatted land		Farm land		Unplatted land outside	
	Per cent of area mortgaged	Ratio of loan to equalized value	Per cent of area mortgaged	Ratio of loan to equalized value	Per cent of area mortgaged	Ratio of loan to equalized value
Akeley	28.12	49.33	48.84	51.24	8.42	34.67
Arago	28.49	42.79	45.28	42.41	18.58	43.40
Badoura	29.43	56.68	27.66	59.60	33.14	50.08
Clay	8.77	43.18	24.72	58.24	5.86	30.02
Clover	17.49	38.68	24.19	32.16	15.75	41.82
Crow Wing	32.02	63.33	48.63	58.16	18.85	81.80
Farden	30.55	62.50	46.58	66.25	12.88	42.36
Fern	24.83	36.60	18.69	38.45	11.45	30.10
Guthrie	34.32	73.40	51.17	77.53	18.66	59.13
Hart Lake	33.82	71.46	40.90	77.19	23.82	51.58
Helga	32.47	69.36	51.16	70.08	10.79	64.55
Hendrickson	18.67	89.36	47.53	101.08	10.23	73.09
Henrietta	43.34	43.84	51.15	43.38	17.73	51.07
Hubbard	40.17	57.49	42.75	58.26	8.19	42.98
Lake Alice	11.35	50.89	38.67	47.16	8.84	53.30
Lake Emma	19.52	47.73	37.53	48.78	12.57	46.37
Lake George	25.35	51.72	51.63	79.69	17.98	29.91
Lake Hattie	25.21	67.17	47.38	56.98	17.37	81.36
Lakeport	40.30	86.11	59.58	99.82	25.69	56.40
Mantrap	36.93	75.69	62.05	78.72	15.13	62.03
Nevis	40.01	72.53	62.76	74.75	15.42	60.24
Rockwood	21.00	63.91	42.05	69.39	10.68	51.19
Schoolcraft	17.18	55.49	34.42	61.55	13.81	51.92
Steamboat River District	13.62	52.95	37.04	39.46	13.17	53.77
Straight River	52.01	43.83	62.19	42.51	21.47	69.86
Thorpe	9.78	43.02	42.36	38.59	4.48	55.43
Todd	29.55	47.74	35.20	48.07	9.54	42.70
White Oak	39.20	58.18	49.39	54.68	17.03	99.33
Total, county	27.85	56.67	46.64	57.46	14.23	53.42

XI. ASSOCIATION OF TAX DELINQUENCY AND MORTGAGE INDEBTEDNESS WITH SOIL TYPE

Tax delinquency and mortgage indebtedness as measures of land value were applied to the various generalized soil types in the county. The tax delinquency map was superimposed on the soil map of the county and the number of 40-acre divisions that were delinquent were counted for each soil type and the acreage of each soil type calculated. The proportion of each soil type that was delinquent was then calculated and expressed as a percentage of the total acreage of each soil type. The same procedure was followed with mortgage indebtedness, and the proportion of each soil type that was mortgaged was calculated.

In general, high tax delinquency and low proportion of mortgage indebtedness are associated with land of low economic value, while low tax delinquency and high proportion mortgaged tend to be associated

Table 91

Association of Soil Type with Tax Delinquency and Mortgage Indebtedness

Soil types	Acres in county	Per cent of of total	Acres delinquent	Per cent delinquent	Per cent of total acres	Acres mortgaged	Per cent mortgaged	Per cent of total mortgaged
Rockwood stony sandy loam	72,771	12.2	58,909	80.91	22.6	9,123	12.59	5.5
Stony soils with gravelly and stony subsoils								
Marquette sandy loam...	24,960	4.2	....	....	....	....	....	....
Marquette loamy sand..	10,560	1.8	....	....	....	....	....	....
Total	35,520	6.0	26,886	75.72	10.3	10,604	29.95	6.8
Rockwood loamy sand.....	36,211	6.1	17,181	47.43	6.6	8,189	22.67	5.2
Loam soils with heavy subsoils								
Rockwood loam	29,824	5.0	....	....	....	....	....	....
Rockwood sandy loam..	128,448	21.5	....	....	....	....	....	....
Nebish loam	14,784	2.5	....	....	....	....	....	....
Beltrami silt loam.....	2,880	0.5	....	....	....	....	....	....
Bluffton loam	9,098	1.4	....	....	....	....	....	....
Total	185,035	30.9	75,901	41.04	29.1	59,960	32.44	36.0
Light sands								
Menahga loamy sand and Kinghurst loamy sand..	85,120	14.2	33,910	39.85	13.0	22,846	26.86	13.6
Peat soils	73,728	12.5	27,793	37.76	10.6	10,370	14.18	6.2
Todd sandy loam.....	51,520	8.6	15,596	30.37	6.0	22,144	43.02	13.2
Dorset sandy loam.....	17,024	2.8	1,926	11.48	0.7	8,616	50.61	5.2
Hubbard loamy sand.....	3,520	0.6	....	....	....	....	....	....
Hubbard sandy loam.....	23,232	3.9	....	....	....	....	....	....
Nymore loamy sand.....	7,552	1.3	....	....	....	....	....	....
Nymore sandy loam.....	5,248	0.9	....	....	....	....	....	....
Total	39,552	6.7	3,059	7.79	1.2	14,347	36.33	8.6
Total for county.....	596,480	100.0	261,161	43.8	100.0	166,196	27.85	100.0

Total of 14,464 acres of poorly drained mineral soils in potholes and flood plains were distributed among the heavy soil types in proportion of total acres of each type.

with those of high economic value. Tax delinquency is considered the more important measure. Mortgage indebtedness is secondary since it depends on factors other than mere loan value, such as land use, with the associated factor of need for loans. Mortgage indebtedness for each type is discussed as a secondary factor. Table 91 shows the data for these economic conditions for each soil type.

Rockwood stony sand loam, considered unfit for agriculture, had the highest proportion of tax delinquency, with 80.9 per cent of that soil type delinquent. The proportion of this soil type that was mortgaged was the lowest of all types, 12.6 per cent. Land in this soil type is practically all in cut-over or residual forest use, with little or no development. It thus produces little or no immediate income from which to pay taxes. Lack of development induces no need for loans. Prospect for a change in these conditions is negligible. Both of these measures agree in indicating that this soil type is the least desirable, and hence least valuable for agricultural purposes, of all soil types represented in the county.

Marquette sandy loam and loamy sand, which are very stony as well as drouthy, were second highest in proportion of delinquency, with 75.7 per cent of their area delinquent. Their general character gives them little immediate value. The proportion mortgaged is fifth highest, with 29.9 per cent of their area mortgaged. Much of their area is in residual forest use.

Rockwood loamy sand was third highest in proportion of area delinquent, with 47.4 per cent delinquent. In proportion mortgaged, it ranked seventh highest, with 22.6 per cent mortgaged. About nine-tenths of this soil type is in residual forest use and hence has low productive and economic value and little need for loans to assist in its use.

The loam soils with heavy subsoils, rock and sandy loam, Rockwood loam, Nebish loam, and Beltrami silt loam, are relatively high in tax delinquency, or fourth highest of all types, with 41.0 per cent of their total area delinquent. This is true in spite of the fact that these soils have the highest potential physical productivity of all the soils in the county. This may be due to the fact that much tends to be stony, somewhat rolling and uneven, and produces a heavy growth, thus offering resistance to its subjugation. Quite a large proportion is still in residual forest use and hence has relatively low economic value. The proportion of these soils that carries mortgage debt is the fourth highest, with 32.4 per cent of its area mortgaged. Its use as residual forest explains its position in relation to mortgage debt. If a larger proportion of its area were in agricultural use, a larger proportion no doubt would be mortgaged with justification, due to its potential physical pro-

ductivity in agriculture. These soils have the greatest possibilities for agricultural development of all undeveloped soils of the county.

Light sands, Menahga loamy sand, and Kinghurst loamy sand have the fifth highest proportion tax delinquent, with 39.8 per cent of their total area delinquent. A substantial area of these types is in water-power use under flowage rights on which taxes are completely paid. This fact tends to reduce the tax delinquency for the types as a whole. These soils are found in flat sand plains that are easily cleared for agricultural use, but are of low ability in physical production. They rank sixth in proportion mortgaged, with 26.8 per cent of their area mortgaged.

Peat soils were sixth highest in tax delinquency, with 37.7 per cent of their area delinquent. The relatively low percentage delinquent may be due to the value of swamp timber still on some soils of this type. These soils rank eighth highest in proportion mortgaged, with 14.1 per cent of their area so encumbered.

Todd sandy loam had the seventh lowest proportion of its area delinquent, 30.3 per cent. The proportion of this type that was mortgaged was 43.0 per cent of its total area, and it had the second highest proportion mortgaged of all soil types. This high proportion mortgaged may be due to relatively low productivity and high need for loans, due perhaps to extensive agricultural development. Low productivity explains the relatively high proportion that is tax delinquent.

Dorset sandy loam had the eighth highest proportion of its area delinquent, 11.4 per cent. The proportion of this soil type that carried mortgage indebtedness was the ninth, or highest of all soil types, 50.6 per cent of its total acreage. The relatively low proportion of tax delinquency is due to the fact that this soil type is economically productive, and the high proportion of area with mortgage indebtedness is explained by the fact that a large proportion of this soil type is highly developed agriculturally, with a consequent need for financing. It also suggests that this soil type is considered a safer credit risk than the preceding types.

The neighboring dark-colored Hubbard and Nymore sandy loams and loamy sands had the lowest proportion of their area delinquent, 7.8 per cent. The proportion of their acreage that was mortgaged was the third highest of all soil types, 36.3 per cent. These soil types are not the most productive in a physical sense, but practically all of their area is included in farms. These soils were largely prairie and hence were easily subdued. They were settled early and are located near the oldest and largest towns in the county.

Measured by tax delinquency and mortgage indebtedness, the soil types of the county may be rated inversely of the order in which they were discussed, i.e., those with highest delinquency and low mortgage debt, as the least desirable, and those with the least delinquency and most mortgage indebtedness, as the most desirable, economically speaking. In this sense, the most desirable may not be the most productive physically. For future and permanent development and economic use, the more physically productive soils would rank higher than they do at present.

XII. TAXATION AND LAND USE

Land in agricultural use not only paid by far the largest share of the total taxes levied in the county in 1928, but was relatively low in tax delinquency. Table 92 is made up of the data on taxation for the various uses of land in the county. Land in agricultural use occupies 44.24 per cent of the total land area of the county. The equalized assessed value of land in agricultural use was 57.69 per cent of the assessed valuation of the county, outside platted incorporated areas. On this valuation 56.08 per cent of the total county tax levy was assessed and 70.23 per cent of the total tax paid was collected. Agricultural land paid 82.8 per cent of the taxes levied against it, or a tax delinquency of 17.2 per cent, as compared with tax payment of 66.11 per cent of tax levied by all uses, or a tax delinquency of 33.89 per cent for the county as a whole. Land operated by its owner occupied 24.56 per cent of the land area of the county and 57.77 per cent of the land in farm use. It paid 43.33 per cent of all taxes paid in 1929 and 87.42 per cent of taxes levied against it, or a tax delinquency of 12.58 per cent. Other types of agricultural use are relatively unimportant either as to area or proportion of total valuation. The proportions of the tax levied against them that were paid are significant. As stated above, land operated by the owner paid 87.42 per cent of taxes levied against it. Land operated by a tenant living on the land paid 85.51 per cent of taxes levied; land operated by nonresident tenants paid 77.67 per cent of taxes levied; meadow, pasture, and waste land outside of farms but in agricultural use paid 67.47 per cent of taxes levied, while idle, abandoned land paid 51.80 per cent of the taxes levied. Proportion of taxes paid apparently varies directly with type of ownership or degree, intensity, or effectiveness of agricultural use. Land operated by the owner tends to keep taxes paid up, but as ownership and operation become more distant, and as personal interest in operation wanes, a larger proportion of taxes becomes delinquent. This also suggests that degree of tax delinquency may be an indication or symptom of deterioration of land use until abandonment results.

The average number of years that delinquent tracts (Jan. 1, 1930) had left taxes unpaid increases from 1.98 years for land operated by the owner to 3.66 years for meadow, pasture, and waste land. Idle or abandoned farm land that was delinquent had been in that tax condition 3.46 years, on the average, somewhat less than meadow, pasture, and waste land, indicating that land once definitely used for agriculture pays taxes as long as possible even after income has ceased. On the

average, 54.7 cents per acre was levied as taxes on all agricultural land. The highest levy per acre was 68.6 cents on land operated by a resident tenant. Inasmuch as the valuation includes land and buildings, the explanation may be in the fact that resident-tenant–operated farms are more highly improved than the average farm operated by the owner. This explanation is supported by a higher valuation per acre for rented land, $11.39, as compared with $9.15 for owner-operated land.

Land in forest use occupying the largest proportion of the area of the county (53.37 per cent) had 38.7 per cent of the total assessed valuation. Based on this valuation, 40.23 per cent of the total tax was levied against land in forest use, and 25.0 per cent of tax paid was paid by this type of land use. Of the tax levied against land in this use, 41.09 per cent was paid, or 48.91 per cent was delinquent.

Commercial and young growing timber is relatively unimportant as to area involved. It is significant that this type of forest use paid 71.88 per cent of the taxes levied against it, indicating potential value and relatively high desirability. Residual or cut-over timber land occupied 51.44 per cent of the area of the county and paid 23.12 per cent of the total taxes paid in the county. Thirty-nine and seven-tenths per cent of the tax levied against it was paid, leaving 60.3 per cent delinquent. Tracts that were delinquent in this use were in that condition on the average about four years, which is somewhat higher than any class in agricultural use. The average tax levied per acre on all forest land was 32.5 cents. Timber land was taxed 38.7 cents and cut-over land 32.3 cents per acre.

Land owned by water-power companies for flowage rights is relatively unimportant except in one township. It occupied 1.26 per cent of the total area of the county, had 0.89 per cent of the total assessed valuation, and paid 1.25 per cent of all taxes paid. It paid 100.07 per cent of the taxes levied against it, the fraction being due to back penalties paid. The average tax per acre was 28.4 cents.

Land used for recreation occupied 1.10 per cent of the land area of the county and had 2.64 per cent of the total valuation of the county, indicating relatively high valuation per unit of area, $15.90 per acre. Of the total tax levy for the county, 2.76 per cent was levied against this type of land use, and 3.47 per cent of all taxes were paid by this land use. In proportion of taxes levied against it that were paid, it ranks about the same as agricultural use, with 82.87 per cent and 17.13 per cent delinquent. The average tax levied per acre was $1.09.

Industrial and residential land outside platted, incorporated areas occupied only 0.03 per cent of the area of the county and is practically negligible. Valuation per acre was high, $16.43, and tax levied per

Table 92

Taxation and Land Use

Land use	Area, acres	Per cent of total	Equalized assessed value	Per cent of total value	Value per acre	Taxes levied	Per cent of total levy	Rate of levy	Taxes paid	Per cent of total paid	Average years delinquent	Per cent of levy paid	Tax levied per acre
Agriculture													
Owner-operated	140,806.58	24.56	$12,878.24	33.93	$9.15	$ 81,085.64	32.77	.063	$ 70,884.81	43.33	1.98	87.42	$0.576
Resident–tenant	29,937.41	5.22	3,410.48	8.99	11.39	20,525.17	8.295	.060	17,550.26	10.73	2.48	85.51	.686
Nonresident–tenant	52,624.25	9.18	4,017.48	10.58	7.63	25,111.17	10.15	.063	19,502.67	11.92	2.48	77.67	.477
Meadow, pasture, waste	11,912.28	2.08	553.55	1.46	4.65	4,571.61	1.85	.083	3,084.43	1.89	3.66	67.47	.384
Idle farm land	18,371.60	3.20	1,037.52	2.73	5.65	7,444.51	3.01	.072	3,856.12	2.36	3.46	51.80	.405
Total	253,651.12	44.24	21,897.27	57.69	8.63	138,738.10	56.08	.063	114,878.29	70.23	...	82.80	.547
Forest													
Timber	11,053.13	1.93	624.39	1.64	5.65	4,282.92	1.73	.069	3,078.61	1.88	4.15	71.88	.387
Residual	294,880.25	51.44	14,066.43	37.06	4.77	95,267.09	38.50	.068	37,821.62	23.12	3.98	39.70	.323
Total	305,933.38	53.37	14,690.82	38.70	4.80	99,550.01	40.23	.068	40,900.23	25.00	...	41.09	.325
Water power	7,202.76	1.26	336.18	0.89	4.67	2,045.53	0.83	.061	2,046.90	1.25	1.00	100.07	.284
Recreation	6,290.89	1.10	1,001.43	2.64	15.90	6,841.17	2.76	.068	5,669.18	3.47	2.53	82.87	1.090
Industrial and residential	189.57	0.03	31.15	0.08	16.43	256.11	0.10	.082	78.07	0.05	1.33	30.48	1.350
Total, county	573,267.72	100.0	$37,956.85	100.0	$6.62	$247,430.92	99.9999	.065	$163,572.67	99.9997	...	66.11	$0.432

acre, $1.35. The proportion of taxes paid was 30.48 per cent, or 69.52 per cent delinquent.

It is apparent that land in agricultural use is the most dependable source of tax revenue, especially when operated by its owner. Recreational land use also ranks high in this respect and merits further encouragement. The high delinquency of cut-over or residual forest land may be due to a relatively high tax being levied per acre when income-producing ability is considered. It is entirely possible that a larger tax revenue could be collected from cut-over land by levying a lower tax.

XIII. ABANDONED FARMS IN HUBBARD COUNTY

Thirty-three abandoned farms were visited. An attempt was made to select farms in representative areas. The farms included were distributed among 13 townships and represented 5 general soil types.

These farms averaged about 99 acres in size, a lower figure than the county average. The average assessed value per acre was $5.29, giving a full and true value of $15.87, which was lower than the average of the land in agricultural use and considerably below that of land operated by the owner. The tax levied on these farms in 1928 averaged $34.97, ranging from $10.23 to $104.96. The average amounted to 36 cents an acre. Only 12 of the 33 farms had paid the entire 1928 taxes and 4 more had paid part. Twelve of the 33 had unsatisfied mortgage indebtedness, averaging $1,169.39 per farm or $10.03 per acre. Fifteen of the 33 farms were located on light sands represented by Menahga and Marquette loamy sands. Nine had sandy loams with light-colored surface soils represented by Marquette and Todd sandy loams. One had a sandy loam soil with dark-colored surface soil represented by Nymore loamy sand. Thus, 24 out of the 33 were on distinctly sandy soil types. Four were on light loam soils, with rolling topography, characterized by Rockwood loamy sand. If these are included among the sandy types, 29 of the 33 were on sandy soils. Only 4 were on medium to heavy loams.

The average acreage once cultivated on these farms was about 16 acres, varying from less than 4 to 50. Fourteen farms were in poor condition. Four were partly cut for hay, and cattle were being run on 3 of them.

The land which had not been cultivated was in forest cover, jack pine predominating on 23 farms, and mixed and aspen on others.

All of the farms had a house, and one had two. These houses had a floor space ranging from 120 to 756 square feet, with an average of 407. The condition of 23 houses was poor, and of 11, fair. Seventeen were frame houses and 10 were log structures. Eight had no barn, and one had two barns. The barns were very small, averaging only 330 square feet of floor space. Nineteen barns were in poor condition, six were fair, and one had tumbled down. Only 13 had poultry houses. Other buildings were 6 sheds, 1 granary, 1 corn crib, and 1 garage. There were no fences on 17 farms; 14 had some barbed-wire fence, and 2 had some woven and barbed-wire fence. Only 7 wells were found on these farms.

The distance from public roads for 22 farms ranged from 4 to 80 rods. Eighteen of these roads were dirt roads and 4 were graded.

XIV. APPENDIX

SURVEY METHODS

Altho the Land Economic Survey has been discontinued, at least for the time being, it is felt advisable to include in this report a somewhat detailed statement of the methods used in making the survey in the event that at some time in the future the survey will be continued.

CONTROL

To faciliate the work of the survey and to insure a reasonable degree of accuracy in the location of the various soil and forest types, it was necessary to locate definitely known land corners or other points that bore some close relation to them. For this purpose, two kinds of control were used. One consisted of running a chained and compassed line along a section line at three-mile intervals in the parts of the county were there were few roads and using a small plane table fitted with a magnetic needle by which it was oriented, while in the other use was made of an automobile equipped with a special measuring speedometer. The latter method is relatively rapid where passable roads or trials are well distributed and has been used for years in the soil surveys made by the United States Department of Agriculture. The only modification of this method as used in Hubbard County was that all section and quarter-section corners were marked with the number of the section or its subdivision. Wherever a road followed a meandering line across a section line or quarter section line this point was marked upon a tree, a fence post or a driven stake, to be used by the field mappers as a starting point or as a place where they could check themselves as they traversed their assignment.

The roads that were traversed were drawn on a sheet of transparent pyralin fastened to the top of the plane table. Beneath the sheet of pyralin was a sheet of plane-table paper on which was drawn a perfect township plat.

Road traverse, or control, always started from a known point. For illustration, assume a road intersection at the southeast corner of Section 16, the center of the township; it might start there. The intersection on the blank township plat is indicated on the pyralin sheet by a pin prick. The plane table was oriented at this point, an alidade placed against the pin in the pinhole, and a sight taken through it to the end of the straight stretch of road. A pencil line was drawn along the edge of the alidade to represent the center of the road. The length

of the straight road, as measured by the speedometer, was then scaled off. The traverse man would then drive to the next point or curve and get the distance from the speedometer reading. Here the plane table would be set up again and a back sight taken on the previous station. The road would then be drawn from the point sighted upon to the present location. The position of the plane table upon the sheet was located by scaling the speedometer distance along this road from the point on which a sight was taken from previous set-up. By this method, the plane table was set up at every other angle in the road. These roads were "tied in" to General Land Office corners whenever it was possible.

All the roads in the county were mapped in this manner. Whenever the line representing the center line of a road crossed a section line or a quarter line, this point was indicated upon a tree or a fence post. This was then called a "control point" and was used by the field mappers as a starting point.

This method of establishng control is relatively rapid, but it is obvious that its use is dependent upon roads being passable to cars. In places where there were no passable roads, it was necessary to establish control by cutting out the section lines between the corners, as on a land survey. This was done at three-mile intervals in the more inaccessible regions of the county.

MAPPING

The mapping was done by six crews of two men each. One man mapped the soil types, and one man mapped the cover types. Each man was furnished with a typewritten description of the forest and soil types he would encounter in the county, in order that the allocation of the forest and soil types observed in the field might be made as mechanical as possible. This reduced the variations in mapping similar types, both soil and forest.

Each pair of mappers was assigned a block of nine sections, or a quarter of a township.

In the actual mapping, the men crossed their blocks at half-mile intervals. Starting from a known point, they crossed three sections, tied in to a control point, and corrected the maps accordingly. They then made a half-mile offset and returned on a line parallel to their first strip.

The men used hand compasses to fix their directions of travel, and distances were measured by counting paces.

In addition to running parallel lines at half-mile intervals through the blocks of nine sections each, the mappers made such offsets as were necessary to determine actually the boundaries of all the types en-

countered. In so doing, the mappers covered the territory for a quarter of a mile on each side of their strip lines. This amounted to running from seven to twelve miles of compass line a day for each crew.

The mapping was done on a scale of two inches to a mile, and forest types of less than ten acres in area were not recorded on the maps unless there was a sharp contrast, such as a pine ridge in an extensive swamp, or a cultivated or abandoned field in a brush or forest area.

Three characteristics of the forest cover were considered in defining the forest type boundaries of the map. In the first place, the tree species growing on the land was recorded by means of symbols. If a single species comprised less than 75 per cent of the stand, the symbols for the two leading tree species were shown. The more important tree species were shown uppermost inside of its type boundary line, and it was called the primary species. The species of lesser importance was next noted and it was called the secondary species. Sometimes, when a third species, the merchantable value of which was greater than that of the secondary species, was present, this species was indicated as a secondary species. In a few instances, a third species was indicated when its volume was about equal to that of the secondary tree species.

The diameter classes of the tree species in the stand were next considered. Three-inch classes were used, namely, 0-1, 1-3, 3-6, 6-9, 9-12, 12-15, 15-18, and 18 inches plus. The diameter class of a tree species was recorded in Arabic numerals following the species symbol, as Pj 3-6.

It is a well-known fact, of course, that the dispersion of the diameters of the trees in a stand usually exceeds three inches, but the diameter class indicated on the map is the average for that particular species. Thus, the foregoing example means that the average diameter for jack pine ranges from 2.6 to 6.5 inches. A considerable number of jack-pine trees will have a greater diameter, and a considerable number will have a smaller diameter, but the 3-6 diameter class is representative of the jack-pine trees as a whole. The average diameter does not necessarily apply to the trees that are most numerous, but it does apply to those trees making the best use of their growing conditions. The criterion for the determination of a tree's efficient use of its habitat, or growing conditions, is the condition of its crown. Consequently, in determining the average diameter of a tree species, that diameter of the tree was indicated, the crown of which predominated in the forest's canopy. Sometimes two diameter classes were indicated for a single species; this depicts what is known as a two-storied stand. Such conditions are most common on cut-over lands.

After the forest mapper had decided which species symbols and

diameter classes to show on his map, he determined the density, or the degree of stocking, of the stand.

The density of a stand in this case shows the completeness with which the trees ulitize the available land and light.

Density is indicated on the map by small vertical dashes written like exponents between the species symbols and the figures giving the diameter class of that species.

Four densities of stocking were recognized:

'''' = well stocked
''' = medium stocked
'' = poorly stocked
° = scattered stocking

The total number of the dashes in the stocking symbol for all the species will equal four in a well-stocked stand and three in a medium-stocked stand. The density of reproduction is based on its own diameter class only; there may be a good stocking of reproduction under a poorly or medium stocked stand.

In a *well-stocked stand* the trees are so numerous and so closely spaced that there is little or no waste of land and light; the individual trees develop small crowns and tall, clean, straight boles. Such stands need no artificial seeding or planting. Well-stocked stands have from 200 to 1500 trees on an acre, depending on their sizes.

In a *medium-stocked stand* the trees are less numerous and there is considerable waste of crown space. Medium-stocked stands have from 120 to 1000 trees on an acre, depending on their sizes.

In a *poorly stocked stand* the trees are scattered, and many develop spreading and limby crowns with short, knotty trunks. Such stands have from 40 to 400 trees on an acre, depending on their sizes.

In a *scattered stand* the trees are very few and far apart. The trees are usually short and limby and, relatively speaking, their merchantable value is low.

Actually, nearly all the understocked stands were quite patchy. Recent logging and fires have left openings from a square rod up to many acres in size in what were well-stocked areas of spruce, jack pine, or Norway pine. Thus, small clumps of well-stocked timber alternating with bare, or nearly bare, land were characteristic of the under-stocked areas.

The symbols for the character of the forest were combined, for example, as follows:

Ha'''' 1-3 = well-stocked stand of aspen, 1 to 3 inches in diameter

Pn'' 9-12 = primary type: a poor stocking of Norway pine 9 to 12 inches in diameter

Pj '' 6-9 = secondary type: a poor stocking of jack pine 6 to 9 inches in diameter. The jack pine is about equal to the Norway pine numerically, but the latter is in a larger diameter class. Incidentally, the stumpage value of Norway pine is greater than that of jack pine, so it is classed as the primary species and diameter class.

Pj '' 3-6 = Probably a cut-over area with a few small jack pines, with an occasional small Norway pine, both species being 3 to 6 inches in diameter.

Pn ° 3-6

The forest mapper also took notes on each stream encountered. Records were also made of the kinds and numbers of game animals encountered, or the signs noted and the kinds of cover in which seen.

The soil surveyors, in addition to showing the boundaries of the soil types, indicated the topography or lay of the land.

THE TIMBER INVENTORY

From a forestry standpoint, a land economic survey would be incomplete if nothing more were done than mapping the cover types. To be of value in determining the management of a forest area, it is essential that it include data on the present merchantable volume, the age of the stand, and the recent volume growth.

A study of the timber growing in Hubbard County was made by the Land Economic Survey. During the first year, an ocular estimate of the stand was made by the forest mappers by taking a quarter-acre sample plot every 2½ chains along the strip. On these plots the number of trees in each two-inch diameter class from six inches in diameter and up were tallied.

To check the classification of the mappers and to get more detailed information concerning the composition of the various stands, the average timber values in the common types, and an index of the productivity of the different types of soils, a two-man sample plot crew was employed.

Two systems of sampling were used. During the first season, sample plots were selected in each of the common forest types and careful measurements were made of the volume of the stand and the current rate of growth. During the second season, a continuous strip survey, in which the same type of information was recorded, was substituted for the mappers' plot estimates and the detailed sample plot work.

During the field season, an attempt was made to get representative areas of the different tree species, sizes, and densities. Care was taken to scatter the plots well over the area mapped. The sizes of the plots

were adjusted in every case to get as good an average as possible of the stand and type as a whole. In general, half-acre plots were taken in the larger diameter classes, one-quarter acre plots in the smaller diameter classes, and one-tenth acre in very small dense stands, while plots up to one acre in size were taken in poorly stocked stands of larger types. The shapes of the plots varied also, depending upon conditions, from squares to elongated strips. Altogether, 94 plots were measured in 1929.

The measurements taken on the sample plots consisted of a tally of all living trees down to one inch d.b.h.,[1] height measurements of a representative number of trees, ages of four or five trees, and current growth rates on trees of various sizes. Current growth and heights were plotted on cross-section paper in the field, so that more data could be collected, if necessary, to fix the curves. From these measurements, sample acre tables were prepared which showed the number of trees, merchantable timber volumes, and rates of growth for the various types mapped.

The strip survey method developed through the field season of 1930 replaced both the selected sample plots and the quarter-acre plots which were taken by the mappers. The latter had proved rather burdensome to the forest mappers. The field procedure was a modification of the Swedish method of timber survey. Strips were run north and south or east and west through the county at three-mile intervals, and a separate tally was made of each of the forest types traversed. This gave a mechanically selected sample of the types mapped. In practice, the location of the strips had to be varied because of the numerous lakes and marshes. However, the lines were all run in cardinal directions, and at least 12 miles of strip were run in each township so the samples are considered fairly representative, at least for the more common types.

The measurements on the strips were similar to those previously taken on the plots, but some short-cuts were made in the interest of greater strip mileage. A separate tally sheet was kept for each type mapped. Starting at the edge of a type, the crew proceded through it, tallying all of the trees on the strip 3 to 6 inches or more in diameter. The trees were calipered by one-inch diameter classes. The widths of the strips varied with the diameter classes of the types. The last two chains of each quarter mile of strip were considered as sample plots, and all trees on these plots were calipered down to six-tenths of an inch d.b.h.

[1] Diameter breast high.

Borings were taken in sample trees to determine their ages and the number of years needed to grow the last 1½ inches in radius. The total and merchantable heights of the trees were also recorded, and the current periodic height growth was measured when possible.

Tally sheets were changed with each change in forest type. At the end of the season all tallies for a single type were averaged together to make a sample for that type. Altogether about 200 miles of strip were run.

In small-sized stands, 0- to 1-inch and 1- to 3-inch diameter classes, instead of tallying the actual number of small trees, the procedure was to tally the number of quadrats (6.6 ft. sq.) which were stocked with one or more forest trees. These quadrats were tallied in a line along the tape and when averaged for a large area gave the percentage of stocking for that type.

From these data, the volumes can be determined for areas of one township or more, and the sample plots can be located on the soil maps and a correlation determined between soil types and tree growth.

LAKE MAPPING

The lake maps were drawn on a scale of four inches to a mile and show the present and former water lines, the inlets and outlets, if any, nature of the beach, character of the water—whether clear or stained, character of the shore line—whether swampy or high, and, if the latter, whether the slope is steep or gentle, and the presence of surface or submerged vegetation.

The location of summer cottages, hotels, resorts, and desirable camp sites was also indicated. In all, 130 lakes were mapped. Copies of these maps may be purchased from the Department of Conservation.

ECONOMIC DATA

The following information was obtained for each 40 acres from the records in the county courthouse:

1. Section, township, range, and date of taking data
2. Name of owner, and area owned
3. Full and true value of land
4. Full and true value of improvements
5. Full and true value of land and improvements
6. Assessed valuation
7. Equalized valuation
8. Taxes levied
    a) General tax
    b) Ditch or special tax
    c) Total tax

9. Taxes paid
    a) June settlement
    b) November settlement
    c) Penalty
10. Delinquent taxes
    a) 1914 to 1927, inclusive
    b) Paid by purchaser
    c) Unpaid delinquent taxes for given years
    d) Amount of unpaid delinquent taxes
11. Mortgage indebtedness
    a) Grantee
    b) Consideration and rate of interest
    c) Date of issue, term, and foreclosure date

The field economist interviewed each township assessor and at least one settler who was thoroly familiar with conditions in each township. From them information was obtained as to what use was being made of each forty in the township. The following uses were recognized:

1. Farming
    a) Owner-operated
    b) Tenant-operated
    c) Vacant, operated
    d) Pasture land
    e) Meadow land
    f) Wood or timber lot
    g) Idle land
    h) Abandoned land
2. Forestry
    a) Timber
    b) Reproduction
    c) Immature timber
3. Water Power
4. Recreation
    a) Commercial resort
    b) Farm resort
    c) Non-commercial resort (churches, clubs, lodges, etc.)
5. Industrial and residential
    a) In villages
    b) Outside villages
6. Miscellaneous, as railroads, churches, cemeteries, schools, etc.

This information was checked against the courthouse data and the cover type maps made by the forest mappers.

XV. RECOMMENDATIONS

HUBBARD COUNTY LAND ECONOMIC SURVEY

The following suggestions and recommendations relating to land-use problems in Hubbard County are offered:

1. State lands: The act providing for the land economic survey specified that recommendations should be made relative to the disposition of state lands within the counties surveyed. It is recommended that lands in Hubbard County now in state ownership be retained in such ownership. The only exception would be land well suited physically and economically for agricultural or other private use.

2. Zoning: The legislature should pass a zoning act giving authority to counties to district the land within their boundaries and to place restrictions upon the use of land not suited to agricultural development in order that further settlement will not take place on land not adapted for farming, with the result that the settlers thereon are unable to obtain a satisfactory income, and the county, towns, and school districts are required to provide public services at undue costs. When the necessary authority has been granted, the Board of County Commissioners should proceed with a zoning program based on information such as that contained in this and other reports on land use. The Board should co-operate and confer with state agencies, especially the Department of Conservation. This recommendation does not contemplate that settlers now in areas which may be zoned as non-agricultural will be compelled to move. The zoning provisions are intended to apply to future settlement.

3. Settler relocation: Settlers now on land not well suited for agricultural use, or so located that the costs of providing them with schools, roads, and other necessary public services are unnecessarily high because of their isolated location, should be assisted in relocating on land well suited for farming and so located that public services are available without heavy additional costs.

4. Delinquent taxes: Hubbard County in common with most of the other cut-over counties is faced with a difficult problem because of the large amount of tax-delinquent land. It is clear that this situation is as much a problem of land use as it is a problem of taxation. Much land has been allowed to become tax delinquent because the valuable timber has been removed, and, with no market for the land or profitable use for it in sight, owners have not found it possible or advantageous to keep taxes paid. Wholesale compromising in tax delinquency, in an endeavor to place the delinquent land back on the tax

rolls, is merely temporizing and does not solve the difficulty. In fact, such settlement may induce further delinquency in the expectation that future settlements will be made.

It is recommended that the policy of bargain settlement of taxes be discontinued. Land definitely tax delinquent should be retained and developed in state ownership unless its classification is clearly agricultural. The state law governing reversion of tax-delinquent land should be amended in order to give the state clear title to such land. Unless and until this is done, the state cannot afford to devote funds to the development of such lands.

5. Forestry: Parts of Hubbard County clearly well suited for forest purposes are either quite unfit or very inferior for agriculture. Some of this land already is included in a state park and a state forest. The boundaries of these may well be extended and tax-delinquent lands added to those already under state control. Intensive management should be practiced only on land well suited for forestry development; the other forest land should be maintained under extensive management. With the forests in Hubbard County and elsewhere in northern Minnesota in their present condition, the outlook is that most of the forestry development will be at the hands of the state and federal governments. However, private development should be encouraged wherever there is reasonable promise of success.

6. Recreation: Hubbard County has extensive recreational facilities that already are serving as a major industry. Careful attention to reforestation, water-level control, and game preservation is important to the maintenance and expansion of recreational opportunities within the county. Encouragement and protection of tree growth are desirable to this end as well as to provide for future timber requirements. Hubbard County and other counties having recreational facilities, through the action of their local officials and private citizens, can do much to preserve and enhance the opportunities in this field.

7. Local government: Sufficient consideration to local needs and to efficient and economical operation has not been given in the adoption of the form of local government and the division of functions among the various units. Legislation should be enacted providing authorization for counties to adjust their governmental machinery to their requirements. For example, a town government may not be required in areas with limited populations and low taxable wealth. Even where the town government is maintained for some functions, it may be found advantageous to assign other functions, such as road construction and maintenance and property assignment, to a larger unit of government, such as the county. The latter is sufficiently large to

acquire and employ more efficient and modern road equipment. Assessment of property for tax purposes is necessarily a sideline and temporary occupation for the township assessor. Larger assessment districts should be authorized by legislative action in order that trained assessment service may be employed.

The system of local school districts employed in Hubbard County and in most of the other counties has very limited possibilities for effecting economies if school service is to continue. A county or other larger district (such as is found in Lake and Koochiching counties) offers possibilities of combining schools, thereby making it possible to provide improved educational opportunities at lower costs. Legislative authorization to effect such reorganization should be granted.

Policies of state aid should be overhauled very carefully to make certain that state aid does not discourage desirable adjustments and that they do not result in a continuance of services on an uneconomic basis and do not encourage undesirable land use.

MINNESOTA
DEPARTMENT OF CONSERVATION

SOIL AND LAY OF THE LAND MAP OF
HUBBARD COUNTY

KEY TO MAP COLORS

SOIL LEGEND

SOIL GROUPS	SOIL NAME	CHARACTERISTICS
LIGHT SANDY SOILS	C — CASS LAKE FINE SAND	Yellowish brown sand on yellowish gray sand. *Gently rolling. Free of stone. Drouthy and drifts readily.*
	M — MENAHGA LOAMY SAND	Grayish brown sand on yellowish gray sand. *Nearly level to gently rolling. Usually free of stone on surface but some gravel and small pebbles in subsoil Drouthy and drifts readily.*
	K — KINGHURST LOAMY SAND	Grayish brown sand on yellowish gray sand. *Undulating to rolling. Some stone usually on the surface and below. Drouthy and subject to drifting.*
	Ar — ARAGO LOAMY SAND	Grayish brown sand on yellowish brown coarse gravelly sand. *Rolling to hilly with surface usually more or less deeply pitted. Cobbles numerous on the surface and below. Occurs chiefly adjacent to lakes. The amount of stone varies greatly within short distances. Drouthy.*
	Bs — BEACH SAND	White or gray sand on sand and gravel. *Forms small ridges of loose white or gray sand adjacent to present lakes or at the edge of former lakes.*
	Me — MARQUETTE LOAMY SAND	Brownish gray loamy sand on reddish brown loose, stony gravelly sand. *Rolling to very hilly. Stones and boulders numerous both on surface and below. Drouthy.*
LIGHT SANDY OR GRAVELLY SUBSOILS	Ms — MARQUETTE SANDY LOAM	Gray sandy loam on compact reddish brown sandy loam over stony gravelly sand. *Rolling to very hilly. Stones and boulders numerous on surface and below. Drouthy.*
	Ts — TODD SANDY LOAM	Yellowish gray sandy loam on compact brown sandy loam over gravelly sand. *Undulating to rolling Usually only a few stones on surface. Drouthy.*
	N — NYMORE LOAMY SAND	Brownish gray loamy sand on yellowish gray loamy sand. *Nearly level to rolling. Free of stone except for occasional layers of gravel in subsoil. Drouthy.*
	Ns — NYMORE SANDY LOAM	Brownish gray sandy loam on yellowish gray loamy sand *Undulating to gently rolling. Usually free of stone on surface with a few below. Drouthy.*
SANDY LOAM SOILS WITH SANDY OR GRAVELLY SUBSOILS	H — HUBBARD LOAMY SAND	Dark grayish brown loamy sand on grayish brown sand and gravel. *Gently undulating to gently rolling. Practically free of stone. Drouthy.*
	Hsl — HUBBARD SANDY LOAM	Dark grayish brown sandy loam on grayish brown sand and gravel. *Nearly level to gently rolling. Practically free of stone. Less drouthy than Hubbard loamy sand. Productive in seasons of favorable rainfall.*
	Ds — DORSET SANDY LOAM	Dark gray sandy loam on cobbly gravelly sandy loam. *Undulating to strongly rolling. Cobbles on surface and below variable. No more drouthy than Hubbard sandy loam.*
SANDY SOIL WITH HEAVY SUBSOIL	R — ROCKWOOD LOAMY SAND	Gray loamy sand on loamy sand over sandy clay. *Undulating to rolling. Amount of stone varies greatly. Depth of sand over the heavy subsoil varies from 3 to 4 feet. Drainage good. Least drouthy where sand cover is shallowest. Occurs in narrow areas between heavy soils and light sandy soils, forming a transition type. Productivity varies greatly within short distances according to depth of sandy layer.*
MEDIUM AND HEAVY LOAM SOILS	Rsh — ROCKWOOD STONY SANDY LOAM	Hilly gray stony sandy loam on stony sandy loam. *Very rough and hilly with stones and boulders numerous, especially on surface. Good drainage except for many deep potholes and ponds. Moderately retentive of moisture but too rough and stony for farming.*
	Rs — ROCKW… SANDY …	Light gray sandy loam on sandy loam. *Gently rolling to hilly. Stones and boulders usually numerous on the surface and below. Drainage good. Fairly retentive of moisture. A productive soil.*
	Rl — ROCKWOOD LOAM	Gray loam on compact heavy loam. *Gently rolling to hilly. Stones and boulders on surface and below, usually less numerous than on Rockwood sandy loam. Drainage fair to good. Retentive of moisture. A productive soil.*
	Nl — NEBISH LOAM	Gray loam on dark brown silty clay over mealy limy clay loam. *Undulating to rolling. Amount of stone on surface and below varies greatly, but usually not enough to prove a serious obstacle to farming. Drainage fair to good. Retentive of moisture. A productive soil.*
	B — BELTRAMI SILT LOAM	Light gray silt loam on brown silty clay. *Undulating to strongly rolling. Surface relatively free of stone. Drainage good. Retentive of moisture. A productive soil.*
POORLY DRAINED MINERAL SOILS	S — SEBEKA LOAMY SAND	Grayish brown loamy sand on yellowish brown sand. *Nearly level with low sandy mounds and narrow swales. Surface drainage usually poor and water table close to surface.*
	Bl — BLUFFTON LOAM	Dark gray loam on gray loam or gray clay loam. *Nearly level, with scattered swales, enclosed basins and wet gentle slopes. Natural drainage fair to very poor. Productive after proper drainage.*
	A — MIXED STREAM DEPOSITS	*Soil varies greatly within short distances ranging from coarse sand to heavy clay. Level. Drainage poor to fair. Borders streams and part is subject to flooding in spring and after heavy rains.*
PEAT AND MUCK SOILS — PEAT	P — PEAT (DEEP)	Brown to black peat averaging more than 2 ft. in depth. *In some places the peat is quite free of woody material while elsewhere it carries numerous stumps, roots and logs at and near the surface. Level. Occupies both small and large bogs. In its natural condition usually water-logged. Very unproductive even after good artificial drainage unless properly fertilized. In most places has an abundance of lime but must be given phosphate, or potash, or both phosphate and potash. Subject to summer frosts. In wet years subject to flooding and in dry seasons to peat fires. When properly drained and fertilized will support very productive meadows and pastures.*
	Ps — PEAT (SHALLOW)	Brown to black peat from 10 in. to 2 ft. in depth, over sand, loam or clay.
	Mu — MUCK	Muck over sand, loam or clay. *Level. Not extensive, usually adjacent to drainage channels. Poor natural drainage.*

KEY TO LAY OF THE LAND

- LEVEL. Flat to gently undulating. From 0 to 2½ feet rise in a hundred.
- GENTLY ROLLING From 2½ to 7½ feet rise in a hundred. Broad, low, billowy swales with long smooth, easy slopes.
- ROLLING. From 7½ to 15 feet rise in a hundred. Easy to moderate slopes, often irregular in direction and variable in grade.
- STRONGLY ROLLING. From 15 to 25 feet rise in a hundred. Moderate to strong slopes. Usually considerable relief.
- STEEP OR HILLY. Over 25 feet rise in a hundred. Hilly, knobby, rough or broken. Slopes bold and abrupt, whether long, short or irregular in direction. Mostly too steep for plowland.

MISCELLANEOUS SYMBOLS

- Soil change
- Pothole or depression
- Short steep slope
- Wet spot
- Soil and subsoil were examined along all roads and in addition along the lines thus indicated.

FIELD WORK
IN COOPERATION WITH
UNIVERSITY OF MINNESOTA, AGRICULTURAL EXPERIMENT STATION,
DIVISION OF SOILS
AND
U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS.

FOR MORE DETAILED INFORMATION ON
HUBBARD COUNTY SOILS
CONSULT THE REPORT ACCOMPANYING THIS MAP.
COPIES OF THIS MAP MAY BE OBTAINED
FROM
MINNESOTA DEPARTMENT OF CONSERVATION, ST. PAUL, MINNESOTA.

CONVENTIONAL SIGNS

CULTURE

City or Village · Industrial Building · Occupied House · Vacant House · Summer Cottage or Hunting Lodge · Resort Hotel · Store · Farmers' Club · Town Hall · Post Office · School House

Abandoned School House · Cemetery · Church · Occupied Logging Camp · Vacant Logging Camp · Former Logging Camp Site · Sawmill · Former Sawmill Site · Inactive Sawmill · Gravel Pit · Minnesota Forest Service Lookout Tower

Graveled Road · Graded Dirt Road · Road with Bridge · Ungraded Dirt Road · Railroad and Station · Abandoned Railroad Grade · Trail · County Boundary · Township Boundary · Reservation Boundary · Section Line · Township and section corners recovered

DRAINAGE FEATURES

River or Large Stream · Lake or Pond · Intermittent Lake or Pond · Submerged Marsh or Floating Bog · Dam · Creek · Intermittent Stream or Drainway · Drainage Ditch · Spring

1 ½ 0 1 2 3 4 Miles

Scale 1 inch = 1 mile
Field Work
1929-1930

A. HOEN & CO. BALTIMORE, MD.